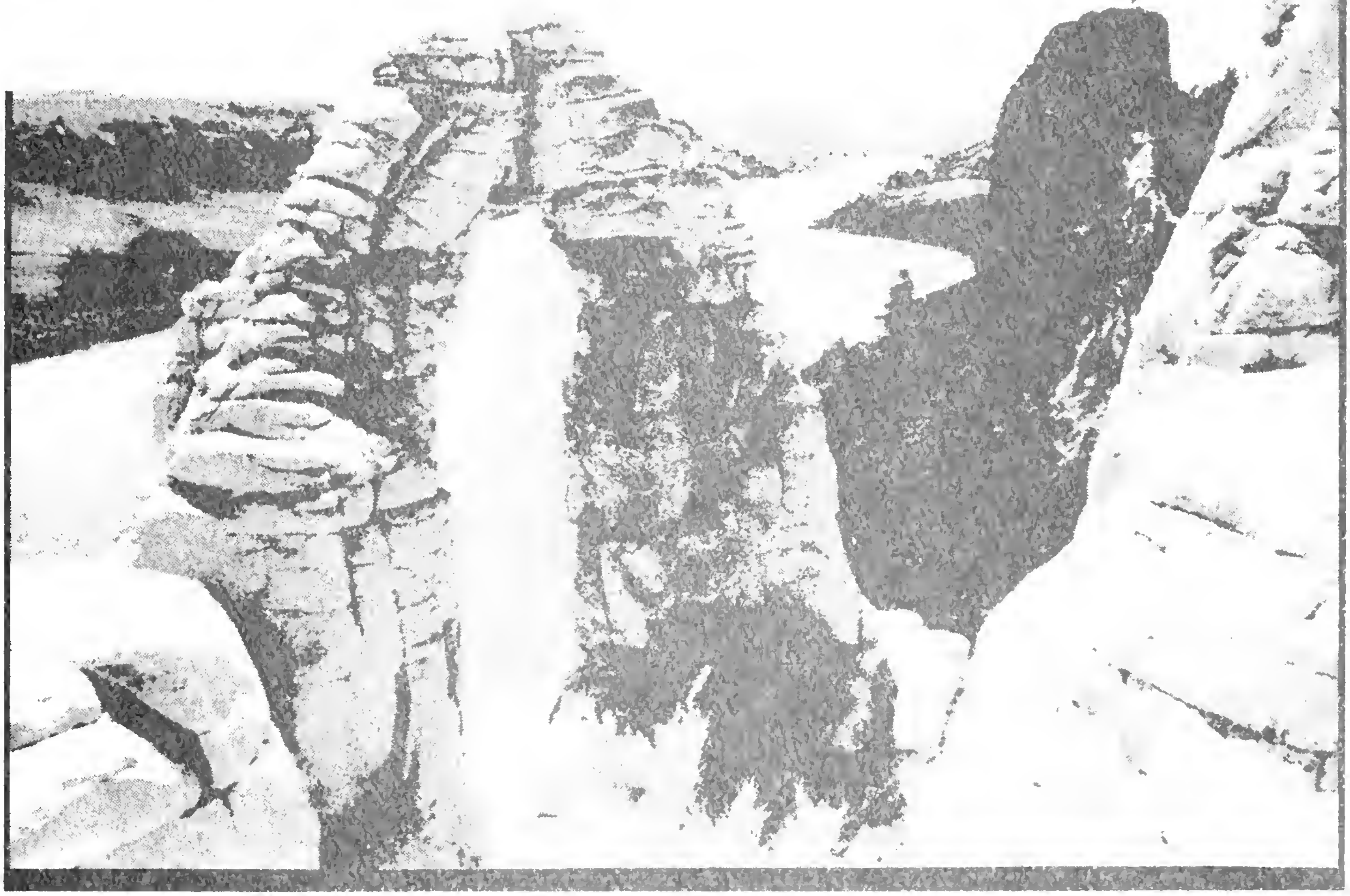
MISSOURI

RIVER BASIN



DRAFT ENVIRONMENTAL IMPACT STATEMENT

FOR WATER RESERVATION APPLICATIONS ABOVE FORT PECK DAM

ABBREVIATIONS

af	—	acre-feet
af/y	—	acre-feet per year
ARM	—	Administrative Rules of Montana
BHES	—	Montana Board of Health and Environmental Sciences
BLM	—	United States Bureau of Land Management
Board	—	Montana Board of Natural Resources and Conservation
BOD	—	biological oxygen demand
BUREC	—	United States Bureau of Reclamation
cfs	—	cubic feet per second
cm	—	centimeter
COD	—	chemical oxygen demand
Corps	—	United States Army Corps of Engineers
DFWP	—	Montana Department of Fish, Wildlife and Parks
DHES	—	Montana Department of Health and Environmental Sciences
DNRC	—	Montana Department of Natural Resources and Conservation
EIS	—	environmental impact statement
EPA	—	United States Environmental Protection Agency
FERC	—	Federal Energy Regulatory Commission
GW	—	gigawatt
GWh	—	gigawatt-hour
kV	—	kilovolt
kW	—	kilowatt
kWh	—	kilowatt-hour
MCA	—	Montana Code Annotated
MEPA	—	Montana Environmental Policy Act
mg/l	—	milligrams per liter
MNHP	—	Montana Natural Heritage Program
MNRIS	—	Montana Natural Resources Information System
MPC	—	Montana Power Company
MW	—	megawatt
MWh	—	megawatt-hour
ppm	—	parts per million
SCS	—	United States Soil Conservation Service
SHPO	—	Montana Historical Society, State Historic Preservation Office
TDS	—	total dissolved solids
TSS	—	total suspended solids
µg/l	—	micrograms per liter
USDA	—	United States Department of Agriculture
USDI	—	United States Department of the Interior
USFS	—	United States Forest Service
USGS	—	United States Geological Survey

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

STAN STEPHENS, GOVERNOR

LEE METCALF BUILDING
1520 EAST SIXTH AVENUE

STATE OF MONTANA

DIRECTOR'S OFFICE (406) 444-6699
TELEFAX NUMBER (406) 444-6721

HELENA, MONTANA 59620-2301

NOTICE - JULY 3, 1991

The Department of Natural Resources and Conservation (DNRC) recently completed its draft environmental impact statement (DEIS) and supporting environmental assessments on proposed reservations of water in the Missouri River Basin above Fort Peck Dam. Reservations of water are sought by the following public agencies:

Conservation Districts:
Big Sandy
Broadwater
Cascade County
Chouteau County
Fergus County
Gallatin
Glacier County
Hill County
Jefferson Valley
Judith Basin
Lewis and Clark County
Liberty County
Meagher County
Lower Musselshell
Pondera County
Teton County
Toole County
Valley County

Municipalities:
Belgrade
Bozeman
Chester
Choteau
Conrad
Cut Bank
Dillon
East Helena
Fairfield
Fort Benton
Great Falls
Helena
Lewistown
Power
Shelby
Three Forks
West Yellowstone
Winifred

State Agencies:
Montana Department of Health and Environmental Sciences
Montana Department of Fish, Wildlife and Parks

Federal Agencies:
United States Bureau of Reclamation
United States Bureau of Land Management

Copies of this DEIS are being circulated for public review and comment for 60 days, ending September 2, 1991. Copies of the environmental assessments are available upon request from DNRC. Requests can be made by calling (406) 444-6627, or by writing DNRC at the address below. Persons making written comments should address comments to:

int 41 - 67054

Larry Dolan
re: Missouri River Reservations
Department of Natural Resources and Conservation
Water Resources Division
1520 East Sixth Avenue
Helena, MT 59620-2301

Informal information meetings will be held prior to the public hearings to answer questions on the reservation process and DEIS. The public hearings will begin at 7:30 p.m. to receive hand-written or oral comments on the DEIS.

			Times	
Where	Location	Date	Informational Meeting	Formal Public Hearing
Helena	Lee Metcalf Building 1520 E. 6th Ave. Board Meeting Room	8/5/91	3:30 - 5:30 6:30 - 7:30	7:30
Roundup	Central Elementary School Multipurpose Room	8/5/91	3:30 - 5:30 6:30 - 7:30	7:30
Big Sandy	High School Multipurpose Room	8/5/91	3:30 - 5:30 6:30 - 7:30	7:30
Great Falls	Great Falls Public Library	8/6/91	4:00 - 5:30 6:30 - 7:30	7:30
Ennis	Town Hall	8/6/91	3:30 - 5:30 6:30 - 7:30	7:30
Valier	Civic Center	8/6/91	3:30 - 5:30 6:30 - 7:30	7:30
Lewistown	Park Inn	8/7/91	3:30 - 5:30 6:30 - 7:30	7:30
Bozeman	Bozeman High School Cafeteria	8/7/91	3:30 - 5:30 6:30 - 7:30	7:30
Glasgow	Best Western Cottonwood Inn	8/8/91	3:30 - 5:30 6:30 - 7:30	7:30
Dillon	Western Montana College Mathews Hall Lewis and Clark Room	8/8/91	3:30 - 5:30 6:30 - 7:30	7:30

The Missouri River Basin Draft Environmental Impact Statement for Water Reservation Applications above Fort Peck Dam and this notice were prepared pursuant to the Montana Environmental Policy Act and the Montana Water Use Act. Copies of the DEIS and this notice were filed with the Governor and the Environmental Quality Council on July 3, 1991. Additional copies of this DEIS can be obtained by calling (406) 444-6627, or by writing to DNRC at the address listed above.

Karen L. Barclay

Karen L. Barclay, Director
Department of Natural Resources
and Conservation

MISSOURI RIVER BASIN

DRAFT ENVIRONMENTAL IMPACT STATEMENT

FOR WATER RESERVATION APPLICATIONS ABOVE FORT PECK DAM

DNRC

Montana Department of
Natural Resources and Conservation

June 1991

SUMMARY

MISSOURI RIVER WATER RESERVATION STATUTE

In 1985, the Montana Legislature directed the Montana Department of Natural Resources and Conservation (DNRC) to begin a basinwide water reservation proceeding for the Missouri River Basin above Fort Peck Dam. The legislature felt that implementation of a water reservation procedure would encourage more coordinated development of the water resources in the basin and would help form a strong and unified basis for protecting Montana's share of the Missouri River water from downstream states. Reservations granted in this process have a priority date of July 1, 1985. Under Montana water law, reservations allow for existing or future consumptive uses of water, and for maintaining instream flows to protect aquatic life, recreation, and water quality. Only public entities such as local governments, conservation districts, and state and federal agencies can apply for and hold water reservations. DNRC was assigned by statute to coordinate the process and to provide technical and financial assistance to conservation districts and municipalities in preparing their applications. The Board of Natural Resources and Conservation (Board) must reach a decision on water reservations applications above Fort Peck Dam by July 1,1992.

APPLICATIONS

DNRC received 40 reservation applications. Eighteen municipalities applied for 34,689 acre-feet per year to meet future growth. Eighteen conservation districts requested 388,137 acre-feet per year primarily for 220 proposed irrigation projects covering 151,571 acres. The Montana Department of Health and Environmental Sciences (DHES) applied to reserve half the average annual flow at four points on the Missouri River (near Toston, Ulm, Virgelle, and Landusky) to maintain dilution of arsenic in the river water. The Montana Department of Fish, Wildlife and Parks (DFWP) applied to reserve instream flows on 283 streams or stream reaches, one lake, and one wetland to protect fish, wildlife, recreation, and water quality. The U.S. Bureau of Land Management (BLM) requested instream flows on 31 streams for fish, wildlife, recreation, and to maintain channel form. The U.S. Bureau of Reclamation (BUREC) applied to reserve 280 cfs or 89,000 acre feet of water per year from the Missouri River. This water would be diverted into the Milk River Basin to relieve water shortages and provide for some new irrigation.

EIS PROCESS

The Montana Environmental Policy Act requires preparation of an environmental impact statement (EIS) for major actions of state government that have the potential to affect significantly the human and natural environment. This EIS examines the environmental, social, and economic impacts of the proposed reservation requests. In the summer of 1989, DNRC held 10 public meetings at different locations throughout the basin to identify important issues for analyses and inclusion in the EIS. An environmental assessment was prepared for each reservation application to provide the basis for the analyses and conclusions contained in this EIS. DNRC also developed a computer model of the Missouri River Basin to assess physical and legal availability of water. This draft EIS is based on the above information and research and analysis by DNRC staff and consultants. Following release of the draft EIS, there will be a 60-day period during which time written comments on the draft EIS can be submitted to DNRC. DNRC also will hold public meetings across the basin to receive comments on the draft EIS. The final EIS will address all substantive comments responding to the draft EIS.

ALTERNATIVES

To address the full range of potential impacts and options available to the Board, DNRC selected four alternatives to analyze in the EIS. They are; the Consumptive Use, Instream, Combination, and No Action alternatives.

Municipalities were included under all three alternatives and given first priority because of the relatively small amount of water requested for that purpose.

The Consumptive Use Alternative emphasizes the use of water for irrigation and municipal purposes. First preference in this alternative goes to municipalities, followed by proposed irrigation projects, and then instream uses. All irrigation projects proposed in the reservation applications were included in this alternative.

The Instream Alternative gives first priority to municipal uses, but emphasizes instream uses for the protection of fish, wildlife, recreation and water quality. Irrigation would have third priority.

To some extent, the Combination Alternative is similar to the Consumptive Use Alternative in that it gives first preference to municipalities, second to proposed irrigation projects, and third to instream uses. It differs primarily in that proposed irrigation projects are only included if they are economically and financially feasible at least 50 percent of the time. A few other projects were excluded or reduced in size on the basis of concerns about land use or other environmental considerations.

Under the No Action Alternative, DNRC describes trends that might unfold through the year 2025 if no water is reserved for any purpose.

BOARD'S AUTHORITY

The Board can grant, modify, or deny any or all of the reservation requests. Applicants must establish to the satisfaction of the Board the following four criteria:

a. the purpose of the reservation,
b. the need for the reservation,
c the amount of water necessary for the reservation, and
d. that the reservation is in the public interest.

Besides these criteria, the Board also must ensure that the reservation applicants make progress toward development of the proposed use with reasonable diligence and that no reservations are granted that would adversely affect senior water rights. To make its decision, the Board will have to abide by the decision criteria described in Chapter Seven and rely on information in the applications, draft and final EIS, individual environmental assessments, and on testimony presented at the contested case hearing.

IMPACTS UNDER CONSUMPTIVE USE, COMBINATION, AND INSTREAM ALTERNATIVES

GENERAL CONSIDERATIONS

Impacts on the existing environment are generally greatest under the Consumptive Use Alternative, less under the Combination Alternative and least under the Instream Alternative. Some proposed projects included in all three alternatives would have substantial impacts. Impacts were not assessed for some of the larger projects where information was not required nor available in the applications. A separate environmental review may be required before some of these projects could be constructed.

WATER QUANTITY AND DISTRIBUTION

Many rivers, streams, reservoirs, and groundwater systems have been altered by existing water uses and could be further modified by any consumptive use project developed through the use of reservations. On some streams, there is not enough water in dry years to satisfy all existing water users. Impacts to streamflows would be greatest under the Consumptive Use Alternative which would reduce flows substantially in the Jefferson, Smith, Sun, Marias, and Teton rivers and in at least a dozen smaller tributary streams. In several of the rivers and streams, late summer streamflows would be reduced to zero or near zero during dry years. Impacts to streamflows would be less under the Combination Alternative and least under the Instream Alternative.

LEGAL WATER AVAILABILITY

By law, water reservations cannot adversely affect the amount of water legally available to holders of water rights with a priority date earlier than July 1, 1985. However, if an existing water right user wishes to change the point of diversion, place of use, purpose of use, or place of storage, all senior and junior water right holders, including those with water reservations, have a right to object to the change if they feel that the exercise of their water rights would be adversely affected. This same legal right allows holders of water reservations to object to water right claims submitted in the statewide adjudication proceeding. Holders of water reservations, like all other water right holders, may seek relief from the district court to protect their water rights.

While water may be physically available for a reservation at the point of diversion, it may already be appropriated by a water user downstream. Existing water users such as irrigators, Montana Power Company (MPC), BUREC, BLM, Indian tribes, and Corps of Engineers already claim most of the flow in the Missouri River and its tributaries. The exact amount of water legally available for future consumptive appropriation, if any, will not be known for some time. However, the statewide water rights adjudication process will determine the size and extent of these water rights.

Canyon Ferry Dam was built to provide water for consumptive uses, primarily for irrigation, while at the same time maintaining the level of hydropower production at MPC's downstream facilities. Soon after Canyon Ferry Dam went into operation, releases from the reservoir increased MPC's downstream electricity generation by an annual average of 106 GWh above the pre-Canyon Ferry level. As more water was consumed for other purposes, the increase above the 1955 level decreased to an average of 84 GWh per year by 1986, and would decrease further to an average of 54 GWh per year under the Consumptive Use Alternative. In the two lowest power years in 10 under the present operating regime, MPC would receive no increase benefits from the reservoir at either the 1986 level of irrigation development or under the Consumptive Use Alternative. However, the problem of high arsenic concentrations in the Missouri River drainage still must be addressed before BUREC will market water stored in Canyon Ferry Reservoir for consumptive uses.

The Blackfeet Tribes have substantial federal reserved water right claims on the Marias River and its tributaries. This special class of water rights might effect both future water reservations and many existing water users.

Water Quality

Water reservations for consumptive use would cause a decline in water quality in some streams and groundwater systems. Higher concentrations of nutrients, pesticides, and salts would be noticeable in some waters, but in most instances the increases would be minor. Short-term increases in sediments would result from construction of reservoirs and diversion structures.

Arsenic concentrations exceeds the federal and state instream standard in the Madison and Missouri river mainstems in Montana. Concentrations also exceed the federal drinking water standard in the Madison River and the portion of the Missouri River upstream from Toston Dam. Arsenic is a known carcinogen. EPA's standard for carcinogens is based on a risk level that would result in one case of skin cancer per million people. Based on this standard and assumption, the risk of skin cancer from arsenic is as high as one case per 77 people at West Yellowstone to about one case in 10,000 people at Landusky. At Toston, the risk of cancer is about one case per 666 people.

Reservations that leads to consumptive water use in the Missouri River basin could increase the concentration of arsenic in the Missouri River and adjacent groundwater systems. Consequently, the risk of skin cancer for people who rely on Missouri River water for drinking would increase unless the arsenic is removed through special treatment. Proposed irrigation projects diverting water from the Madison River into the Gallatin drainage and from the Missouri River into the Milk drainage would increase arsenic levels in the Gallatin and Milk rivers. Instream reservations would not change water quality but may not be adequate to preserve flows for arsenic dilution.

Soils and Stream Channel Form

In general, reservations that would result in the conversion of rangeland to irrigation would affect soils through the loss of organic matter, reduced water holding capacity, and increased susceptibility to erosion. These effects would be somewhat offset once an alfalfa crop is established. Where reservations convert dry cropland to irrigation, soil structure will improve, erosion will decrease, and nitrogen and organic fertility will increase. Forty-three projects may have substantial soil impacts and these are identified in Chapter Six. Other effects of consumptive use projects on soils are generally minor.

Impacts to stream channels generally would be minor. In some instances, consumptive water uses could decrease channel capacity by increasing the deposition of sediment. Instream reservations would not change existing stream channel forms.

Land Use

Proposed irrigation reservations would convert nonirrigated cropland, pasture, and rangeland to irrigated fields. The amount of irrigated cropland would increase in the basin by about 24 percent

(208,000 acres) under the Consumptive Use Alternative, 15 percent (129,000 acres) under the Combination Alternative and 5 percent (40,000 acres) under the Instream Alternative. Forty-two irrigation projects may have other substantial land-use impacts and these are identified in Chapter Six. Other land use impacts are generally minor.

Fish and Aquatic Habitat

Low flow conditions already stress game fish populations and aquatic habitat on some rivers and streams in the basin. Further consumptive uses would generally worsen conditions on these rivers and streams. Streams most severely affected by the proposed consumptive use reservations include the Jefferson River near Waterloo and Three Forks, the Boulder River above Cold Springs, the Marias River, the lower portions of the Sun and Teton rivers, and eight tributaries. Streams where the effects could be less, include the Gallatin, Missouri, Judith, Dearborn, and Smith rivers and seven smaller tributary streams. Stored water could be released from Tiber Reservoir to offset most water depletions in the lower Marias River. Reservations for instream flows would help maintain the existing aquatic habitat and fisheries.

The effects of flow reductions on the pallid sturgeon, a federally listed endangered species, are not known. It is possible that four of the proposed storage projects could support a fishery., On large irrigation projects, fish could be killed in the diversion structures, though this could be minimized through proper design.

Wildlife

Proposed irrigation projects could affect wildlife by altering habitat. Thirty-six irrigation projects would convert native grassland to irrigated cropland on big game winter range and would reduce the amount of native forage available to wintering elk and deer. Losses of winter range could stress wildlife during the winter and early spring and increase depredation on crops and hay. DFWP has identified 70 proposed irrigation projects with a high potential for crop damage from wildlife. Most of these projects are near or within existing winter ranges.

Birds of prey (raptors), waterfowl such as ducks and geese, and aquatic mammals such as mink and river otter could be affected by consumptive use reservations. However, in most cases, site specific information is not available to determine the extent of the effect, if any. Grouse and birds of prey would be affected by local disturbance during nesting and brood rearing periods. Reduced streamflows would make waterfowl more vulnerable to predation and also would limit food supplies for aquatic mammals which would render them more susceptible to predation.

Vegetation

Impacts to vegetation would result from replacement of natural plant communities with agricultural crops, inundation of riparian and upland plant communities by reservoirs, reduced stream flows, and increased proliferation of noxious weeds. However, it is difficult to determine impacts on riparian and wetland plant species such as cottonwoods, sedges and rushes, and dominant tree species. No Montana plants are federally listed as threatened or endangered species. Probably the most significant vegetation effect is the increased risk of spreading noxious weeds.

Historical, Archaeological, and Paleontological Sites

Proposed consumptive use reservations would affect 60 known historical, archaeological, or paleontological sites. Most sites are located on private land where formal evaluation is not required to determine if some sites might be eligible for listing on the National Register of Historic Places.

Storage

Reservations may reduce water available for future storage projects. However, reservations generally would not preclude storage of spring runoff flows, but could make storage projects less economically feasible. Existing water rights could be a greater constraint to the development of new storage than water reservations. Development of consumptive use reservations would decrease reservoir levels in Canyon Ferry, Fort Peck, and Tiber reservoirs. The reservation applications include 15 water storage projects, and together they would store a relatively small amount of water.

Recreation

Instream reservations would help maintain streamflows on streams and rivers that are important to recreation and tourism. Recreational use of water in the Missouri River Basin in Montana totaled over 2 million recreation days in 1989. About 61

percent of the total recreation use is on rivers and streams and 39 percent on reservoirs. The most important recreational resources in the basin from an economic perspective are the streams in the Headwaters Subbasin such as the Beaverhead, Big Hole, Gallatin, and Madison rivers. The total net economic value of water-based recreation in the basin above Fort Peck Dam is $144 million per year.

Recreational use could decline under all three alternatives as flows decrease in rivers and streams. The effects would become more severe as additional water is withdrawn from streams that already have low flows during dry years, such as the Gallatin, Jefferson, Boulder, Smith, Dearborn, Sun, Teton, Judith, and Musselshell rivers, Belt Creek, and the Marias River above Tiber Reservoir.

Instream flow values range from $35 an acre-foot per year on headwater rivers and streams during July and August, to $2 an acre-foot per year on Middle Missouri and Marias/Teton Subbasin streams during the rest of the year. The value of recreation losses is estimated to be $3,198,000 per year under the Consumptive Use Alternative, $1,621,000 per year under the Combination Alternative and $310,000 per year under the Instream Alternative.

HYDROPOWER

Consumptive use reservations would eventually increase the cost of electricity to ratepayers. They would do this by: 1) decreasing streamflows that are used to generate electricity and 2) requiring production of additional electricity. These two actions would require production of replacement power that would be considerably more expensive than existing power supplies. The total monetary impact to ratepayers would range from $11.5 to $30.4 million per year under the Consumptive Use Alternative, $4.8 to 12.8 million per year under the Combination Alternative, and $1.7 to $5.1 million per year under the Instream Alternative. The cost of replacing power used under the Consumptive Use Alternative (in excess of revenue received for irrigation pumping) would range between $5.9 to $19.3 million per year; $2.8 to 8.4 million under the Combination Alternative, and $1 to $4 million under the Instream Alternative.

AGRICULTURE

Development of irrigation projects in the basin under any alternative would have a positive effect on jobs, personal income, taxes, and agricultural sales. Benefits would be greater in the Marias/Teton and Middle Missouri subbasins than in the Upper Missouri and Headwater subbasins. About 30 jobs would be created under the Instream Alternative and about 106 under the Consumptive Use Alternative. Personal income in the basin would increase between $1,749,723 and $6,066,878 per year. County tax receipts would increase between $59,563 and $158,440 per year. Agricultural sales would increase between 1.0 percent and 3.5 percent.

SOCIAL EFFECTS

The reservations would not noticeably change the social character of communities in the Missouri River basin. The agriculture community will remain stable, and the recreation and tourism-related services would still constitute a growing segment of the local economy.

NO ACTION ALTERNATIVE

If the Board were to deny all reservation applications, consumptive water users could still apply through the water use permitting process to appropriate water for beneficial uses. If most or all direct flows are appropriated by existing water users such as MPC and irrigators, a potential user could buy an existing water right and change the use. Municipalities could condemn existing water rights to meet future needs.

Irrigated agriculture probably would remain stable. Some new irrigation projects would be built in the basin. This number probably would be offset by the amount of irrigated land going out of production because of low farm prices brought on by high yields on good lands.

If instream reservations are not granted, instream flows in many streams and rivers would not be protected by a water right. In some instances, increased consumptive uses could lead to streams becoming very low or going dry, resulting in adverse impacts to water quality, aquatic life, recreation, and wildlife. Murphy water rights, large hydropower water rights, and federal and state water quality standards for arsenic would provide some level of instream flow protection in some streams and rivers.

If and when Missouri River flows are divided among basin states, Montana claims for future use would be stronger with consumptive use reservations in place.

If present trends holds, few large storage projects will be built over the next 25 years. Emphasis during this period will probably will be on rehabilitation and enlargement of existing facilities as defined in the state water plan.

BOARD DECISION CRITERIA

The decision of whether to grant, modify, or deny the reservation applications rests with the Board, which must abide by several criteria which are discussed below. The ability of the requested reservations to meet these criteria is examined in DNRC's research and analyses of the reservation applications, as explained in Chapter Seven. These results are preliminary and do not represent recommendations on whether any reservation request satisfies any of these criteria. Such determinations are made by the Board.

QUALIFICATION AND PURPOSE

All applicants are qualified to reserve water through the Missouri River Basin water reservation proceeding. The purposes for all reservation requests are beneficial uses under Montana law.

NEED

A water reservation is needed if "there is a reasonable likelihood that future instate or out-of-state competing water users would consume, degrade, or otherwise affect the water available for the purpose of the reservations" or if "there are constraints that would restrict the applicant from perfecting a water permit for the intended purpose of the reservation" All applicants identified a need to reserve water. Conservation Districts want to secure water for agricultural production before the water is appropriated by other users in Montana or by downstream states. They also want to have the option to develop this water when the economic climate improves. Municipalities want to appropriate water to meet future growth when available water supplies are diminishing in the basin. DFWP and BLM want to have secure instream flows to protect fish, wildlife, recreation, and water quality. DHES wants to secure instream flows to protect the public from increased risk of cancer from arsenic concentrations which are already high. BUREC desires to divert Missouri River water to reduce shortages in the Milk River basin.

AMOUNT

The Board must determine the amount needed to fulfill the purpose of the reservations. This amount must be based on accurate and suitable measuring methods and determinations that no reasonable cost-effective measures could be taken within the reservation term to increase efficiency and lessen the amount of water required.

Conservation Districts' requests are based on recorded crop requirements and efficiency of proposed irrigation systems. The majority of the projects were designed for efficient sprinkler irrigation.

Three agencies requested instream flows. DFWP employed several methods, but used most frequently the Wetted Perimeter Inflection Point Method (WETP). This method provides an indication of streamflows necessary to maintain aquatic habitat in riffle areas. The BLM used the same wetted perimeter method to determine yearly minimum flows, but also used channel geometry methods developed by USGS for determining flows necessary to maintain channel stability. DHES feels that any new consumptive use development would increase the risk to cancer based on the high arsenic concentrations in the Missouri River and that all remaining unappropriated flows are needed to protect public health. DHES, however, is limited by statute to request half the average annual flow on gauged streams and this is the amount requested at 4 points on the Missouri River.

Municipalities requested enough water to service population growth to the year 2025. Increased population multiplied by per capita rate of consumption was used to calculate the total amount requested in the applications. Per capita rates were based on actual use requirements for each community. Based on the 1990 census, 11 of the 18 projections of population growth, and the associated amounts of water requested, may be higher than actually will occur.

BUREC based the amount of its request on supplemental water requirements for existing irrigated lands along the Milk River and on the Fort Belknap Indian Reservation, and the water necessary for full-service irrigation of lands on the Rocky Boy's Indian Reservation and lands adjacent to the proposed canal. Present and future water conservation measures will relieve some of the water shortages in the basin. Since it is not known how much water will be saved through conservation nor the actual

amount the Tribes will need to satisfy their federal reserved water rights, it is difficult to determine the adequacy of the amount that BUREC requested in its application for the Virgelle diversion project.

Public Interest

Reservations for municipal water supplies and irrigation would provide monetary benefits to basin communities. However, they would have costs by decreasing streamflows which could adversely effect recreation and hydropower production. Reservations for consumptive uses would also use additional power, which would eventually require the production of higher-cost electricity. The value of an acre-foot of water for instream flow is based on recreation and electricity production. Table S-1 identifies the total benefits and costs of water uses under the three alternatives. Net benefits per year are greatest under the Combination Alternative ($351.8 million), slightly less under the Instream Alternative ($338.5 million) and considerably lower under the Consumptive Use Alternative ($152.7 million).

Municipal water developments have benefits that exceed costs by $341.3 million because of the small amount of water consumed and the high value of this use under all three alternatives (Table S-2). In contrast, proposed irrigation projects consume large amounts of water. Total costs associated with the depletions would exceed total benefits by $188.6 million per year under the Consumptive use Alternative, $27.2 million per year under the Combination Alternative and $2.8 million per year under the Instream Alternative (Table S-2).

The value of an acre-foot of water for instream and consumptive uses can be compared when reservations for the two uses are both requesting the same water. Sixty-two proposed irrigation projects would value an acre-foot of water at a greater level than the instream values, and 157 proposed irrigation projects would value water less than the instream values. The value of an acre-foot of water for all municipal reservations exceeds the instream flow and proposed irrigation project values. Instream flow values are greatest in the Headwaters Subbasin where the recreation value is the highest and where each acre-foot of water can be passed along to be used to generate hydroelectricity at downstream hydropower facilities. Instream values decline progressively with distance downstream but the value of water for irrigation remains more consistent throughout the basin.

On each stream or stream reach, the number of requests that will give the greatest net benefit is based, in part, on the amount of water available. However, water availability may not be definitely known before the Board acts on the reservation requests.

Table S-1. Benefits and costs of water use under three alternatives

	($ million)[a]		
	Consumptive Use	Instream	Combination
Irrigation	134.1	38.7	119.9
Municipal	343.2	343.2	343.2
Recreation	-70.3	-6.7	-35.7
Hydropower Production	-213.4	-27.6	-87.3
Replacement Power	-40.9	-9.1	-18.0
Total	152.7	338.5	351.8

a Positive values represent benefits and negative values represent costs.

Table S-2. Benefits and costs of municipal use and irrigation use under three alternatives

	($ million)[a]		
	Consumptive Use	Instream	Combination
Irrigation			
benefits	134.1	38.7	119.9
costs	-322.7	-41.5	-139.1
net	-188.6	-2.8	-27.2
Municipal			
benefits	343.2	343.2	343.2
costs	-1.9	-1.9	-1.9
net	341.3	341.3	341.3

a Positive values represent benefits and negative values represent costs.

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GLOSSARY

Aquifer: A porous subsurface formation that contains groundwater.

Consumptive water use: Any use of water that results in water being consumed by plants, evaporated, or otherwise lost from its source and unavailable for other use.

Contested case hearing: A public hearing held if valid objections from existing water right holders are received to water reservation applications. The findings of the hearing will be submitted to the Board which will use them when reaching a decision on the water reservation applications.

Dead storage: In a reservoir, water which cannot be withdrawn because it is below the level of the outlet.

Discharge: The total volume of water in a stream passing a given p oint over a given period of time—quantified in this EIS as cubic feet per second or "cfs."

Gigawatt: One billion watts, 1,000 megawatts.

Headwater benefits: Increased hydropower production capabilities the Montana Power Company receives as a result of releases of stored water by the U.S. Bureau of Reclamation from Canyon Ferry Reservoir.

Irrigation return flow: Water that returns to a surface water body after irrigation.

Mitigation: In the case of environmental impacts, an effort to avoid, minimize, or reduce such impacts.

Nanogram: One billionth of a gram (.000000001 grams).

Net present value: The value today of a sum of money that will be paid or earned in the future.

Percentile exceedance flows: Flow rates which have been equalled or exceeded at a given frequency over a given period of record (see page 43 for further explanation).

Pick-Sloan power: Power marketed at cost to congressionally designated preferred customers under the Pick-Sloan Plan at savings of as much as $0.0015 per kWh over alternative sources.

Pick-Sloan Program: A program initiated by Congress as part of Flood Control Act of 1944. It is the development plan for the Missouri River basin's system of dams, reservoirs, and associated projects. The goal of the program was to "secure the maximum benefits for flood control, irrigation, navigation, power, domestic and sanitary purposes, wildlife, and recreation."

Riparian: Relating to or living on the bank of a stream or other water body.

Water diversion: The removal of water from its source by use of a canal, ditch, pipe, or other conveyance.

Water rights, permits, reservations, etc.: See Chapter Two for definitions of all terms relating to water law.

CHAPTER ONE
INTRODUCTION

In 1985, the Montana Legislature directed the Department of Natural Resources and Conservation (DNRC) to initiate and coordinate a proceeding that allows public entities (state and federal agencies and subdivisions of the state) to reserve water in the Missouri River basin of Montana for future use. This reservation proceeding was initiated for two reasons. First, it was thought that the comprehensive planning required in a reservation process would encourage more efficient development of the water resources in the basin. Second, the reservation proceeding was seen as a way to build a strong legal basis for protecting Montana's share of Missouri River water in any future litigation with other states or in a congressional apportionment of the water between states.

The legislature was particularly concerned that downstream states might litigate for the guaranteed delivery of Missouri River flows from Montana. Montana can best prepare for negotiation or litigation by identifying its present and future water needs and legally reserving water in amounts sufficient to meet those needs.

In reservation proceedings, local governments, conservation districts, and state and federal agencies are encouraged to apply to reserve water for existing and future water-consuming uses or to maintain a minimum flow, level, or quality of water (§85-2-316, MCA). Under the law, DNRC is responsible for assisting in preparing the reservation applications and for coordinating the reservation process. The Board of Natural Resources and Conservation (Board), a governor-appointed group of seven citizens, decides whether to grant, deny, or modify reservation requests. The Board's decisions on reservation applications in the Missouri basin will be based on a record of evidence that includes the information provided in the applications, environmental impact statement, and a contested case hearing.

Due to the vast size of this basin, the Missouri reservation proceeding has been split into two parts. Applications for water in the upper portion of the basin, which encompasses the drainage area upstream from Fort Peck Dam, are being considered first. After an environmental review and contested case hearing, final decisions on the upper basin applications will be made by the Board before July 1, 1992. This draft environmental impact statement (EIS) addresses only those applications for the reservation of water in the basin upstream from Fort Peck Dam. Applications for water in the basin below Fort Peck Dam and in the Little Missouri and Milk river basins had to be compiled by July 1, 1991, and will undergo similar review and hearings. The Board has until December 31, 1993, to act on these applications. Any reservation granted in either the upper or lower portion of the basin will receive a July 1, 1985, priority date (except for the Little Missouri River basin, where the priority date will be July 7, 1989).

EIS PROCESS

This draft EIS was prepared to satisfy the Montana Water Use Act and the Montana Environmental Policy Act (MEPA). MEPA requires that an EIS be prepared to address government actions that might significantly affect the quality of the environment. DNRC determined that the reservations, if granted, met these criteria and that preparation of an EIS was required. This EIS provides information to the Board to use in deciding whether it should grant, modify, or deny water reservations that have been applied for in the Missouri basin. It also serves to inform the public of the possible environmental consequences of any action by the Board on the pending water reservation applications.

This EIS addresses all pending water reservations requested in the basin above Fort Peck Dam and describes in general terms the reservation requests and the parties and resources that would be affected if the requests are granted. Significant, basin-wide issues and the cumulative effects of granting the reservations are the main focuses of the EIS.

Detailed project assessments were completed on all reservation applications. These assessments were used in preparing this draft EIS and are available for review by contacting DNRC in Helena.

The public has several opportunities to participate in the EIS process. In the first of these, public meetings were held to help determine the issues that should be examined in the EIS. These issues, along with information from state and federal agencies, were combined with research results and other data to form the basis for the draft EIS. The draft EIS will be distributed to the public to give interested parties the opportunity to review and comment. DNRC will then hold additional public meetings to gather written and oral comments. DNRC will then evaluate the comments and publish a final EIS that contains DNRC's responses to comments and provides information on issues raised following publication of the draft EIS.

CONTESTED CASE HEARING

After the final EIS is distributed to the public, DNRC issues legal notice to water right holders and other interested parties of the reservation applications and accepts written objections. If valid objections are received, the Board appoints a hearings examiner, and a formal contested case hearing is held. At the hearing, applicants and objectors present testimony and evidence. This is the final opportunity for public involvement. The hearings examiner then presents findings and recommendations to the Board. Based on its review of this record, the Board adopts findings and issues a decision that can fully grant, partially grant, modify, or deny requested reservations.

WHO HAS APPLIED

The application deadline for water reservations in the basin above Fort Peck Dam was July 1, 1989. DNRC received applications from 18 conservation districts to provide water for 220 new and supplemental irrigation projects, from 18 municipalities, and from the U.S. Bureau of Reclamation (BUREC) to divert water from the Missouri to alleviate water shortages in the Milk River basin. The Montana Department of Fish, Wildlife and Parks (DFWP) applied for instream flows on 283 stream segments, the Montana Department of Health and Environmental Sciences (DHES) for instream flows at four points on the main stem to protect water quality, and the U.S. Bureau of Land Management (BLM) for instream flows on 31 headwater stream segments to protect fisheries and wildlife. A more detailed list and discussion of the applicants' requests are presented in Chapter Three.

AGENCIES WITH ADDITIONAL PERMITTING AUTHORITY

If the Board grants reservations, other agencies may have additional regulatory jurisdiction over project development. These agencies are listed in Table 1-1.

Table 1-1. Agencies with regulatory jurisdiction relating to water reservations

Conservation districts	Private projects that affect the bed or banks of perennial streams
County	Floodplain permit for facilities within designated floodplains
Department of Fish, Wildlife and Parks	Governmental projects that affect streams; consultation with conservation districts regarding private projects
Department of Health and Environmental Sciences	Water quality and air quality permits, solid and hazardous wastes
Department of Natural Resources and Conservation	Water Use Permit and Change of Use Permit; dam safety construction permit
Department of State Lands	Easements across state lands
State Historic Preservation Office	Archaeological and historical resources survey
Federal Energy Regulatory Commission	Licensing and relicensing of hydropower facilities
U.S. Army Corps of Engineers	404 water quality and wetland disturbance permits; easements across public lands
U.S. Bureau of Land Management	Special use permit; Upper Missouri Wild and Scenic River; easements across public lands
U.S. Fish and Wildlife Service	Endangered and threatened species; federal projects that affect streams
U.S. Forest Service	Special use permit; easements across public lands

CHAPTER TWO

MONTANA WATER LAW

INTRODUCTION

Water use in Montana is generally guided by the prior appropriation doctrine. One of the legal principles under the prior appropriation doctrine is "first in time is first in right." The first person to use water from a source establishes the first right, the second person is free to divert flows from what is left, and so on. During a dry year, the person with the earliest priority date has first chance at the available water to the limit of his or her established right. The holder of the second earliest priority date has the next chance, and so on.

Another central element of the prior appropriation doctrine is that the water must be put to beneficial use. The Montana Supreme Court has stated that beneficial use is the "basis, measure, and limit" of a water right. McDonald v. State, 220 Mont. 519 (1986). Under Montana law, beneficial uses include, but are not limited to, agriculture (including stock water), domestic, fish and wildlife, industrial, irrigation, mining, municipal, power, and recreational uses. The nature and extent of a water right is defined by how water has been beneficially used in the past. Once a water right is established, it can be lost through abandonment if the beneficial use is not continued.

Under the prior appropriation doctrine in Montana, there are various "types" of water rights depending on what procedure for obtaining a water right was in force at the time the right was established. However, the basic principles of first in time, first in right, and beneficial use apply to all types of water rights acquired under state law.

The most significant change in how water rights are created and administered occurred in 1973 when the legislature enacted the Montana Water Use Act. The Water Use Act, effective July 1, 1973, recognized and confirmed water rights that had been used in the past. But, because there were only incomplete records to determine what water had been used, the act also created a system for filing claims and adjudicating those historical rights. This adjudication process also includes water rights claimed under federal law by Indian tribes and the federal government. Further, the act established a new administrative permit system for obtaining a water right after July 1, 1973.

STATE WATER RIGHTS

EXISTING RIGHTS

Water rights created prior to 1973 are commonly referred to as existing rights. One way existing rights were obtained was by filing for the water with the county clerk and recorder and then putting the water to beneficial use. Such a right is called a filed right. A filed right has a priority date as of the date of filing, if the appropriator diligently put the water to beneficial use. Existing rights also were obtained by diverting, impounding, or withdrawing water and putting it to beneficial use (use right). The priority date for a use right was the date the water was actually put to beneficial use. Some existing water rights (decreed rights) were adjudicated and recorded by local district courts as a result of water disputes. Finally, a special class of existing rights (Murphy rights) were created by the legislature to preserve instream flows on 12 blue ribbon trout streams.

A 1979 law required all holders of water rights created prior to July 1, 1973, to file a claim for those rights by April 30, 1982, or they would be deemed abandoned. The Water Court is conducting a general statewide adjudication to determine the validity of all claimed pre-1973 rights. (When a judge hears a case and renders a decision, the matter is said to have been *adjudicated*. In the matter of water rights, *adjudication* refers specifically to the settling of claims filed for water rights.) Refer to Chapter Four for a discussion of the status of the adjudication in the Missouri River basin.

Permits

Since the enactment of the Water Use Act of 1973, persons seeking to obtain a water right must apply for a permit from DNRC. The priority date for a water use permit is the date that the application is accepted by DNRC. For a summary of existing water right claims and permits by type of use in the Upper Missouri River basin, see Appendix A. For a discussion of new permits issued upstream of Morony Dam in the Missouri River basin, refer to Chapter Four.

Water Reservations

Montana has created a unique class of water rights labeled water reservations. Under the water reservation system, water is appropriated for instream or future water-consuming uses. Essentially, water reservations are very similar to water right permits. However, there are important distinctions in who can hold this type of water right, the requirements for establishing the rights, the process for obtaining them, and in some cases the possibility of having the rights reallocated to another use. Under the water reservation statute, only state or federal agencies or political subdivisions of the state may apply for a water reservation (§85-2-316(1), MCA). Water reservations may be acquired for any beneficial use.

The water reservation statute is the only means to acquire a water right for instream flows to protect water quality, fish, wildlife, and recreation. The purpose of instream flows is to maintain a minimum flow, level, or quality of water throughout the year or a period, or for a length of time designated by the Board. These flows can be reserved without the usual requirement for withdrawal, impoundment, or diversion of the water and implemented immediately upon being granted. The water reservation statute also allows water to be appropriated now for future consumptive use. By appropriating the water now, the reservant maintains an early priority date even through it may be years or decades into the future before the water is actually developed.

The Board of Natural Resources and Conservation is responsible for issuing orders adopting water reservations. Before an order reserving water may be adopted, the applicant must establish to the Board's satisfaction:

1. The purpose of the reservation
2. The need for the reservation
3. The amount of water necessary for the purpose of the reservation
4. That the reservation is in the public interest

The Board's decision-making process regarding water reservations is covered by the Administrative Procedure Act (APA). Under the APA, appeal for judicial review by the district court is provided for any party who fully participates in the contested case hearing (typically not persons offering public testimony only) and who is aggrieved by the Board's final decision (§2-4-704(1), MCA).

However, the district court is limited in what it can review. The court will review only the record established by the Board and will not consider new evidence or testimony unless the appellant can show good reason why it wasn't presented to the Board. The court cannot substitute its judgement for the Board's, but can only modify or reverse the Board's decision if:

1. The administrative findings, inferences, conclusions, or decisions are:
   (a) In violation of constitutional or statutory provisions;
   (b) In excess of the statutory authority of the agency;
   (c) Made upon unlawful procedure;
   (d) Affected by other error of law;
   (e) Clearly erroneous in view of the reliable, probative, and substantial evidence on the whole record;
   (f) Arbitrary or capricious or characterized by abuse of discretion or clearly unwarranted exercise of discretion; or
2. Findings of fact upon issues essential to the decision were not made, though they were requested (§2-4-704(2)(a,b), MCA).

The district court's decision can be appealed to the Montana Supreme Court.

These criteria are discussed further in Chapter Three. For proposed uses requiring a diversion or storage facility, each applicant must submit a detailed development plan.

A water reservation, when adopted, becomes a water right. However, if the objectives of the reserva-

tion are not being met, the Board can later modify or revoke that water right. The Board must review water reservations at least once every 10 years to ensure that the objectives of the reservation are being met. In the case of instream flows granted by the Board, all or a portion of the flow may be reallocated to a different use if the applicant for reallocation is a qualified reservant and can show that the instream flow is not required for its purpose and that the need for reallocation to the applicant outweighs the need shown by the original reservant. (§85-2-316(11), MCA.)

Several water reservation rights have been established in the Yellowstone River basin. In 1978, the Board granted water reservation applications for agriculture (stock water), irrigation, municipal, fish and wildlife, water quality, and storage.

Two water reservation applications in the upper Clark Fork basin, one for instream flows and one for two storage projects for agricultural purposes, are currently pending.

All water reservations granted in the Missouri River basin under the present reservation process will have a priority date of July 1, 1985. (§85-2-316, MCA.) However, the Board must set the relative priorities within the July 1, 1985, date for the different reservations.

In 1989, the legislature added the Little Missouri River basin to the Missouri River basin reservation process. Applications for water reservations for the Little Missouri River basin must be submitted to DNRC by July 1, 1991, and the Board must make a final determination on these reservations by December 31, 1993. However, the priority date for any water reservations that may be granted in the Little Missouri River basin pursuant to this process will be July 1, 1989.

Persons who receive a water use permit on the Missouri River with a priority date between July 1, 1985 (or July 1, 1989, in the case of the Little Missouri River) and the date the Board adopts an order granting a water reservation may seek to have any or all reservations subordinated to the permit. However, for the Board to subordinate a reservation to a permit, the permit holder must show that the subordination will not interfere substantially with the purpose of the reservation.

Federal Reserved Rights

A federal reserved water right is a right implied by an act of Congress, a treaty, or an executive order establishing a tribal or federal reservation. These rights arise out of federal, not state, law. The amount of water reserved under such a right depends on the purpose for which the land was reserved. In Montana, reserved water rights have been claimed for seven Indian reservations inside the state and Indian allotments for members of the Turtle Mountain Chippewa Tribe, whose reservation is in North Dakota. Reserved water has also been claimed for federal land holdings in Montana, including the national parks, forests, wildlife refuges, and a federally designated wild and scenic river. (See Chapter Four.)

The nature and extent of each reserved right will be determined through the statewide adjudication process. The Montana Reserved Water Rights Compact Commission, created in 1979, is authorized to negotiate settlements with federal agencies and Indian tribes that claim federal reserved water rights within the state. These claims are suspended from the adjudication while they are being negotiated by the compact commission.

WATER LEASING FOR INSTREAM FLOWS

The 1989 legislature authorized DFWP to lease existing water rights for instream flows (§85-2-436, MCA) as part of a study program. The purpose of the legislation is to examine the feasibility of leasing existing water rights to maintain and enhance streamflow for fisheries. This four-year pilot program allows DFWP to lease water from willing water right holders.

WATER QUALITY

The Montana Department of Health and Environmental Sciences (DHES), in conjunction with the Board of Health and Environmental Sciences (BHES), administers programs and laws to protect, maintain, and improve the quality of water for all beneficial uses. Under the authority of the Montana Water Quality Act and the Federal Clean Water Act, DHES enforces water quality standards for surface water and groundwater, issues permits for wastewater discharges, reviews the operation and maintenance of

municipal and industrial wastewater treatment facilities, and monitors wastewater discharges and ambient water quality. DHES also is responsible for toxic substance control and oversight of activities affecting water quality to ensure compliance with the Federal Clean Water Act and the Montana Water Quality Act.

The Montana Water Quality Act establishes surface water quality standards and a water use classification system to protect, maintain, and improve the quality of water. Montana's classification scheme is summarized in Table 2-1.

Montana's water quality classifications are based on beneficial uses and reflect the state's varied water quality problems and natural conditions. Specific physical, chemical, and biological criteria are used to establish the quality of water necessary to support a given beneficial use (Table 2-2). Specific numeric criteria are not listed in Table 2-2 for some parameters because the level at which uses are impaired depends on temperature, pH, and water hardness.

To protect beneficial uses, DHES has adopted water quality standards that establish maximum allowable changes in surface water quality parameters for each stream on the basis of its classification. Standards vary for each classification (Table 2-1). Most streams in the upper Missouri are within the A and B classifications. Levels set for toxic and deleterious substances in the "Gold Book" of the U.S. Environmental Protection Agency (EPA) (U.S. EPA 1986 and 1987) also have been included in Montana statutes by reference.

Montana administers a variety of programs to protect groundwater quality. The Montana Ground Water Pollution Control System was approved by BHES in October 1982. The program includes

Table 2-1. Montana water classifications for specific uses

A-CLOSED CLASSIFICATION: Waters classified A-Closed are suitable for drinking, culinary, and food processing purposes after simple disinfection.

A-1 CLASSIFICATION: Waters classified A-1 are suitable for drinking, culinary, and food processing purposes after conventional treatment for removal of naturally present impurities.

B-1 CLASSIFICATION: Waters classified B-1 are suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

B-2 CLASSIFICATION: Waters classified B-2 are suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

B-3 CLASSIFICATION: Waters classified B-3 are suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

C-1 CLASSIFICATION: Waters classified C-1 are suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

C-2 CLASSIFICATION: Waters classified C-2 are suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

C-3 CLASSIFICATION: Waters classified C-3 are suitable for bathing, swimming, and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl, and furbearers. The quality of these waters is naturally marginal for drinking, culinary, and food processing purposes and agricultural and industrial water supply. Degradation that will impact established beneficial uses will not be allowed.

I CLASSIFICATION: The goal of the State of Montana is to have these waters fully support the following uses: drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of fisheries and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

Table 2-2. Water quality criteria for protection of beneficial uses (maximum values in milligrams/liter unless otherwise noted)[1]

Parameters	HH(FW)[2]	PWS[3]	A(C)[4]	A(W)[5]	REC[6]	AGR[7]
Dissolved oxygen	narrative[8]		≥7.0	≥5.0		
Fecal coliforms[9]					200	1,000
Nitrite as nitrogen		1.0	0.06	5.0		10.0
Nitrate as nitrogen	10.0	10.0				100
Total ammonia	narrative[8]	0.5				
Un-ionized ammonia	narrative[8]		0.03	0.03		
Total inorganic nitrogen			1.00	1.00		
Total phosphorus			0.10	0.10	0.10	
Total dissolved solids	250.0	500				1,200
Conductance (micromhos/cm)	narrative[8]					1,800
Turbidity (NTU)[10]	narrative[8]		10	50		
Total suspended solids	narrative[8]		30	90		
Chloride		250				700
Sulfate		250				
Cyanide	0.2	0.2	0.0052	0.0052		
Sodium						160
Sodium adsorption ratio						5.0
Fluoride		2.4				2.0
Arsenic	0.000020	0.05	0.19	0.19		0.10
Barium		1.00				
Boron	1.0					0.75
Chromium VI	0.050	0.05	0.011	0.011		1.00
Chromium III	170.00	0.05	0.210	0.210		
Iron	0.3	0.3	1.0	1.0		20.0
Manganese	0.050	0.05				10.0
Selenium	0.010	0.01	0.035	0.035		0.02
Mercury	0.000144	0.002	0.002	0.002		0.01
Copper		1.0	0.012	0.012		0.5
Lead	0.05	0.05	0.003	0.003		0.10
Zinc		5.0	0.047	0.047		10.0
Cadmium	0.010	0.01	0.001	0.001		0.05
Nickel	0.0134	0.015	0.096	0.096		2.0
Silver	0.05	0.05	0.004	0.004		
pH (minimum)[11]		6.5	6.5	6.5	6.5	4.5
pH (maximum)[11]		8.5	8.5	9.0	8.5	9.0
Temperature (C)	narrative[8]		19.4	26.6		
Temperature (F)	narrative[8]		67.0	80.0		

≥ Greater than or equal to

1 Criteria shown are generalized guidelines for protecting various beneficial uses. Criteria listed for some parameters have been adopted as enforceable standards. These standards vary by stream classification—see 16.20.603 ARM (Water Quality, Subchapter 6) for a complete description of water quality standards.

2 Human Health (Fish and Water): U.S. EPA "Gold Book" values for ambient surface water—based on consumption of fish and water.

3 Public Water Supplies: Federal drinking water standard for municipal water.

4 Aquatic Life (Cold Water): Maintenance and propagation of salmonid or cold water fisheries.

5 Aquatic Life (Warm Water): Maintenance and propagation of warm water fisheries.

6 Recreation: Suitability for swimming and waterborne recreation.

7 Agriculture: Suitability for irrigation and livestock consumption.

8 Recommended criteria are given in narrative form—single numeric values are inappropriate (see ARM 16.20.601 through 16.20.630).

9 Measured in geometric mean number of organisms per 100 milliliters.

10 Nephelometric turbidity units—a measure of light penetration through water.

11 Measured in pH units that indicate hydrogen ion concentration.

groundwater quality standards, a classification system, a permitting program for potential pollution sources, and a nondegradation policy. The program has focused on mine discharges, ruptured pipelines, and spills of hazardous materials. In 1989, the Montana Agriculture Chemical Ground Water Protection Act (HB 757) was enacted by the legislature. The act authorizes education, groundwater monitoring, setting of groundwater standards for agricultural chemicals, and development of groundwater management plans. These programs are relatively new and in the initial stages of implementation. Groundwater supplies used for drinking water must meet the criteria for public water supplies (Table 2-2).

Water quality standards are enforceable and, if violated, will impair one or more of the beneficial uses for a given classification. Along with the surface water quality standards, BHES has established Montana nondegradation rules that prohibit increases in concentration of substances in surface water and groundwater for which limits are set by the federal Safe Drinking Water Act. These rules also apply to substances listed in EPA's "Gold Book."

Sections 305(b) and 106(e) of the Federal Clean Water Act require states to submit a biennial report to EPA describing the quality of their surface water and groundwater. This report is the primary document in Montana for guiding water quality management and for reporting on progress in achieving the goals of the Federal Clean Water Act and Montana Water Quality Act.

CHAPTER THREE

DESCRIPTION OF RESERVATION REQUESTS

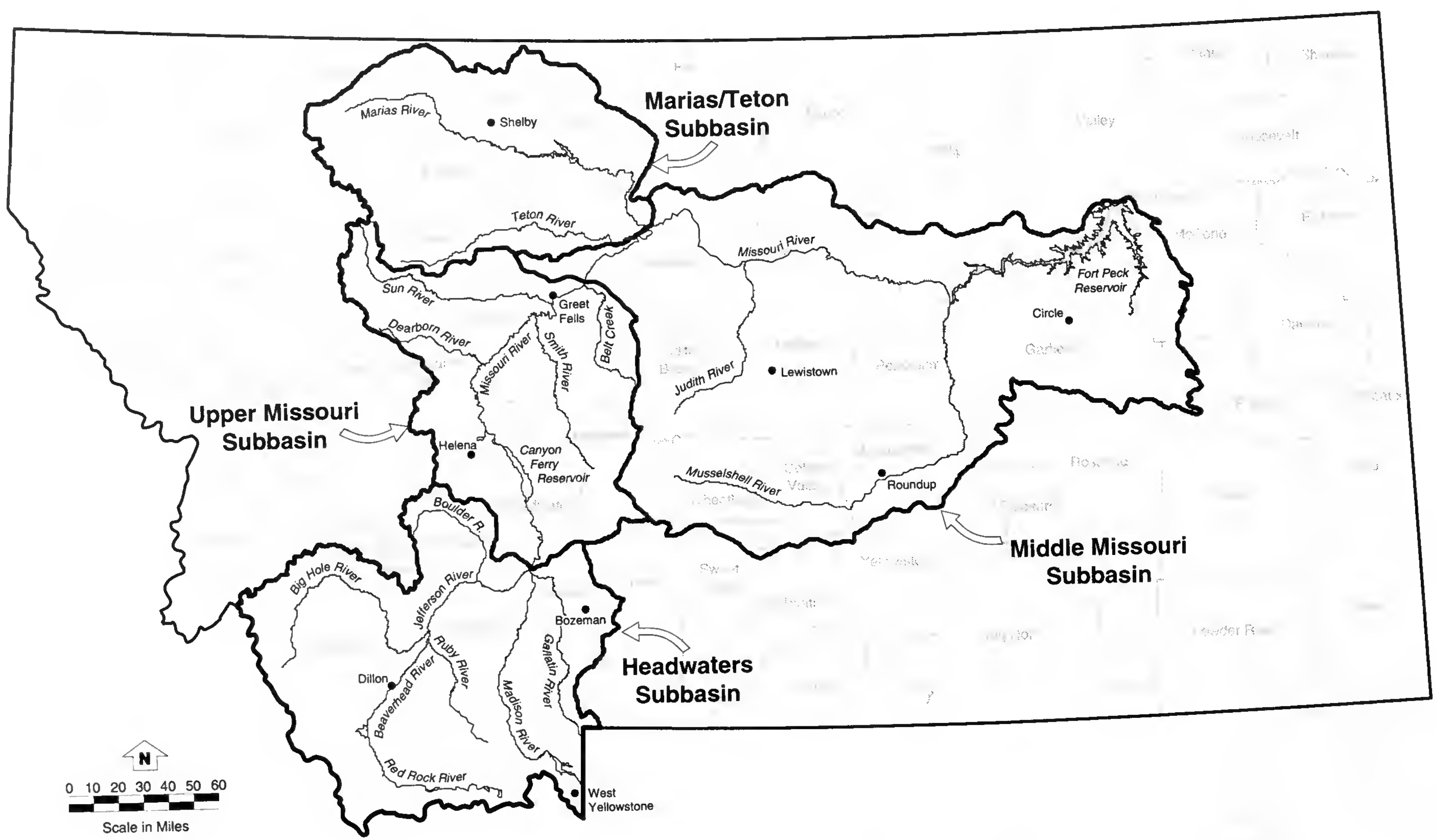
In this chapter, the actions proposed by each applicant are summarized. These summaries present the views and findings of the applicants as expressed in their reservation applications. DNRC evaluated this information and presents its results in Chapters Five through Seven. Each summary includes:

1. The purpose of the reservation request
2. The need for the reservation
3. The methods used by the applicants to determine the amount(s) of water requested
4. Why the reservation is in the public interest

DFWP, DHES, and BLM applied to reserve water for instream flows. Although the purpose of the reservation applications from these three applicants varies, much of the water requested could be shared and still meet the intended purpose of each. By law, the instream reservations together cannot exceed 50 percent of the average annual flow of record on gauged streams. This restriction does not apply on ungauged streams. More specific information can be found in the applications and in the project assessments on file at DNRC.

To help simplify the discussion of the reservation requests and the resources affected by them, the portion of the Missouri basin above Fort Peck Dam has been divided into four subbasins (Map 3-1). The *Headwaters Subbasin* includes the Madison, Gallatin, and Jefferson rivers and their tributaries above Three Forks. The Missouri River and its tributaries from Three Forks to the confluence of Belt Creek are included in the *Upper Missouri Subbasin.* The *Marias/Teton Subbasin* includes the Marias and Teton rivers and their tributaries. The remainder of the Missouri River drainage, from Belt Creek to Fort Peck Dam, falls into the *Middle Missouri Subbasin.*

Map 3-1. Missouri River subbasins



CONSERVATION DISTRICT APPLICATIONS

Eighteen conservation districts applied to reserve water, primarily for irrigation. The 18 conservation district applications include 220 proposed irrigation projects. Individual projects would use both surface water and groundwater, and water storage is proposed in some instances. In their applications, all conservation districts stated similar purposes, needs, and public interest criteria, and they used similar methods for determining amounts of water needed. The reservation requests included in the conservation district applications are presented in Table 3-1 and shown on Maps 3-2 through 3-5.

PURPOSE

The general purpose of the conservation district applications is to reserve water for new irrigation projects or to provide supplemental water for existing irrigation. If a conservation district's reservation request is granted in full or part, the landowners or lessees whose projects have been included in the application would be eligible to use that water. The districts would administer the distribution of reserved water among district cooperators. The reservations would help ensure that water would be legally available for the irrigation projects identified in the applications.

NEED

The need to reserve water for the proposed irrigation projects results from (1) the threat to future water availability within the conservation districts arising from water demands of downstream states and other prospective users, (2) a desire to improve long-range planning efforts, and (3) the prospect that higher prices for farm products in the future will make additional water-dependent agricultural production economically feasible.

DETERMINATION OF AMOUNT

The conservation districts determined how much water to reserve by identifying potential irrigation projects and then determining the amount of water required to irrigate them. The districts, along with DNRC and the consultant the districts hired to help with the applications, first relied on the knowledge of private operators to identify potential irrigation projects. Project designs for potentially irrigable land identified in previous studies (DNRC 1987) were also included with the approval of conservation district supervisors. The physical availability and quality of the proposed water sources were then considered in screening projects to be included in the reservation applications.

Stream gauge data were used to calculate available water for some projects, while flows were estimated in many ungauged watersheds (DNRC 1991). Groundwater availability was determined on a case-by-case basis using available data and knowledge of local aquifer characteristics.

For land where water was found to be physically available, engineering analyses were made of potential irrigation systems, cost estimates were prepared, and crop irrigation requirements were determined. The suitability of soils for irrigation at the project sites was also considered in the screening process. Lastly, the economic and financial feasibilities of the proposed development plans were assessed. Projects not eliminated in any stage of this screening process were used as the basis to determine the amount of water requested in the conservation district applications.

PUBLIC INTEREST

The conservation districts consider the reservation requests to be in the public interest for three reasons. First, irrigation is defined as a beneficial water use in Montana (§85-2-102, MCA), and in the past, the Montana Legislature directed DNRC to recognize the primary role of agriculture in the state's economy when allocating water development funds. Second, the reservation applications serve to identify consumptive uses for currently unappropriated water. Third, the development of future irrigation projects in the conservation districts would bring economic benefits to farmers, ranchers, and other people in the counties and surrounding communities.

Table 3-1. Conservation district reservation requests

Project Number	Point of Diversion TWN	RGE	SEC	Peak Flow (cfs)	Annual Diversion (af)	Water Source	Project Acres
Big Sandy							
BS-31	T29N	R9E	31	0.49	74	Marias River	32
BS-32	T29N	R9E	30	9.86	1,506	Marias River	639
BSS-2	T29N	R9E	30	289.61	44,608	Marias River	19,230
							19,901
Broadwater							
BR-5	T9N	R1E	25	2.98	362	Canyon Ferry Lake	182
BR-11	T9N	R1E	27	0.98	119	Canyon Ferry Lake	60
BR-12	T9N	R1E	27	1.31	159	Canyon Ferry Lake	80
BR-14	T8N	R1E	23	5.64	746	Canyon Ferry Lake	375
BR-28	T7N	R3E	32	1.88	249	Well (Deep Creek)	125
BR-29	T7N	R3E	30	0.69	84	Well (Deep Creek)	30
BR-34	T6N	R2E	33	3.76	497	Missouri River	250
BR-35	T5N	R1E	5	3.76	497	Well (Crow Creek)	250
BR-38	T5N	R2E	22	0.63	109	Well (Warm Springs Creek)	80
BR-40	T4N	R1E	4	1.07	126	Well (Warm Springs Creek)	125
BR-41	T4N	R1E	10	4.26	506	Well (Warm Springs Creek)	500
BR-42	T4N	R1E	2	0.68	81	Well (Warm Springs Creek)	80
BR-44	T4N	R1E	21, 28	9.40	1,243	Well (Warm Springs Creek)	625
BR-50	T3N	R2E	23	4.92	596	Missouri River	300
BR-52	T2N	R1E	27, 28	0.66	80	Jefferson River	40
BR-101	T2N	R2E	18	77.40	11,515	Jefferson River	3,190
BR-103	T9N	R1E	10	34.10	5,066	Canyon Ferry Lake	1,700
BR-104	T8N	R2E	17	151.40	22,491	Canyon Ferry Lake	6,095
BR-106	T10N	R1E	30	5.58	676	Canyon Ferry Lake	340
BR-107	T10N	R1E	29	2.30	278	Canyon Ferry Lake	140
BR-108	T9N	R1E	11	1.89	229	Canyon Ferry Lake	115
BR-109	T9N	R1E	14	2.13	258	Canyon Ferry Lake	130
BR-110	T9N	R2E	6	3.85	467	Canyon Ferry Lake	235
BR-111	T5N	R2E	36	0.66	80	Missouri River	40
							15,087
Cascade County							
CS-21	T20N	R2W	5	0.95	140	Big Coulee	56
CS-31	T21N	R1W	33	0.79	94	Sun River	38
CS-32	T21N	R1W	32	0.70	87	Sun River	35
CS-42	T20N	R6E	24	5.94	443	Belt Creek	124
CS-43	T20N	R6E	24	3.98	599	Belt Creek	255
CS-44	T20N	R7E	18	0.55	83	Belt Creek	35
CS-51	T21N	R1W	33	1.53	177	Sun River	70
CS-52	T20N	R1W	8	0.72	90	Sun River	36
CS-61	T19N	R2E	15	1.15	163	Smith River	79
CS-62	T17N	R2E	25	1.06	141	Hound Creek	59
CS-63	T17N	R2E	25	1.83	129	Hound Creek	42
CS-64	T17N	R2E	24	0.83	100	Hound Creek	42
CS-71	T15N	R4E	30	0.30	42	Smith River	17
CS-101	T18N	R1W	25	2.15	304	Missouri River	148
CS-102	T17N	R1W	11	1.39	186	Missouri River	79
CS-111	T19N	R2E	20	6.58	799	Missouri River	381
CS-159	T21N	R7E	32	0.76	114	Belt Creek	48
CS-171	T21N	R1W	35	0.50	70	Sun River	28
CS-231	T20N	R1W	2	0.18	26	Sun River	10
CS-241	T21N	R1E	26	1.48	190	Sun River	76
CS-251	T19N	R2E	26	1.65	245	Smith River	91
CS-252	T19N	R2E	15	0.57	77	Smith River	28
CS-271	T19N	R2E	23	0.93	134	Smith River	50
CS-331	T18N	R2E	26	0.41	57	Smith River	24
CS-351	T18N	R1W	35	2.73	369	Missouri River	171
CS-471	T21N	R1W	28	0.92	126	Sun River	50
CS-541	T19N	R2E	8	0.54	69	Missouri River	30
CSI-11	T17N	R1W	20	2.23	287	Missouri River	120
CSI-12	T17N	R1W	20	0.90	110	Missouri River	46
CSI-21	T17N	R1W	16	1.50	157	Missouri River	66
CSI-22	T17N	R1W	11	1.19	163	Missouri River	69

Project Number	TWN	RGE	SEC	Peak Flow (cfs)	Annual Diversion (af)	Water Source	Project Acres
	---------Point of Diversion--------						
CSI-23	T17N	R1W	11	1.61	144	Missouri River	61
CSI-31	T17N	R1W	2	0.82	109	Missouri River	46
CSI-32	T17N	R1W	1	0.65	86	Missouri River	36
CSI-33	T18N	R1E	30	1.10	150	Missouri River	62
CSI-34	T18N	R1E	18	1.17	164	Missouri River	60
CSI-35	T18N	R1E	17	1.69	253	Missouri River	108
CSI-41	T18N	R3E	12	1.44	180	Missouri River	66
CSI-51	T19N	R2E	19	1.78	250	Missouri River	92
CSI-52	T19N	R2E	8	4.65	700	Missouri River	298
CSI-71	T20N	R2W	4	1.32	198	Sun River	79
CSI-81	T21N	R1E	34	0.71	96	Sun River	38
CSI-82	T21N	R2E	31	1.03	137	Sun River	55
CSI-83	T21N	R2E	30	0.49	99	Sun River	39
CSI-91	T21N	R2E	34	0.98	129	Sun River	47
CSI-92	T20N	R3E	6	0.50	72	Sun River	26
CSI-101	T19N	R2E	4	1.57	223	Missouri River	108
CSI-102	T19N	R2E	9	1.28	171	Smith River	72
CSI-103	T19N	R2E	11	3.71	557	Missouri River	237
CSI-111	T18N	R2E	2	6.32	843	Smith River	387
CSI-120	T17N	R3E	20	1.17	133	Smith River	56
CSS-200	T20N	R3E	8	82.02	11,885	Sun River	5,053
							9,429
Chouteau County							
CH-21	T25N	R1E	31	2.64	406	Missouri River	175
CH-181[a]	T21N	R14E	7	0.00	38	Cut Bank Coulee	—
CH-201	T22N	R9E	35	0.54	77	Shonkin Creek	29
CH-211	T23N	R7E	7	2.94	382	Missouri River	142
CH-371	T25N	R9E	32	0.22	30	Missouri River	11
CH-381	T24N	R6E	5	9.90	1,912	Teton River	584
CH-511	T23N	R6E	34	10.24	1,577	Missouri River	680
CH-541	T22N	R6E	22	0.21	37	Highwood Creek	13
CH-551	T21N	R7E	12	0.64	86	Spring, Big Sag Coulee	32
CH-641[b]	T24N	R4E	33	0.00	53	Alkali Coulee	—
CHI-10	T25N	R10E	20	2.36	314	Missouri River	116
CHI-21	T25N	R10E	8	5.29	752	Missouri River	280
CHI-22	T25N	R10E	2	3.06	389	Missouri River	144
CHI-30	T26N	R11E	10	4.19	643	Missouri River	279
CHI-40	T26N	R12E	5	1.89	290	Missouri River	126
CHI-51	T25N	R9E	11	1.63	244	Marias River	98
CHI-52	T26N	R9E	32	3.33	255	Marias River	73
CHI-53	T25N	R9E	10	1.88	289	Marias River	125
CHI-61	T25N	R7E	33	1.72	247	Teton River	107
CHI-72	T24N	R6E	11	0.69	107	Teton River	46
CHI-74	T24N	R7E	6	0.69	106	Teton River	46
CHI-80	T25N	R5E	28	0.80	122	Teton River	53
CHS-1	T21N	R6E	25	20.23	3,117	Belt Creek	1,343
CHS-3	T23N	R7E	8	127.62	19,654	Missouri River	8,475
CHS-5	T25N	R9E	36	58.81	9,058	Missouri River	3,905
CHS-6	T25N	R10E	21	232.95	35,814	Missouri River	15,382
							32,264
Fergus County							
FE-41	T19N	R16E	27	0.85	103	Judith River	61.3
FE-42	T19N	R15E	27	0.38	44	UT Campbell Coulee	23.0
FE-81	T18N	R15E	2	3.33	403	Wolf Creek	239.2
FE-111	T15N	R18E	25	0.21	25	Big Spring Creek	12.0
FE-141	T15N	R18E	7	3.23	375	Wolverine Creek	222.3
FE-161	T17N	R17E	23	2.16	261	Lincoln Ditch	155.1
FE-401	T14N	R19E	23	0.55	64	East Fork Big Spring Creek	38.2
FE-431	T15N	R18E	21	1.06	107	Little Casino Creek	55.0
FE-561	T17N	R17E	16	3.30	382	Warm Springs Creek	227.5
FE-671	T14N	R16E	19	6.43	748	Olsen Creek	443.4
FE-672	T14N	R16E	19	3.82	444	UT Olsen Creek	263.8

[a] No irrigated acres. Storage will be used for fire protection and recreation.
[b] No irrigated acres. Storage will be used for wildlife enhancement.
UT - Unnamed tributary

Project Number	----------Point of Diversion-------- TWN	RGE	SEC	Peak Flow (cfs)	Annual Diversion (af)	Water Source	Project Acres
FE-673	T14N	R16E	30	1.13	131	UT Ross Fork Creek	77.7
FEI-10	T23N	R16E	27	1.59	192	Missouri River	114.0
FEI-20	T23N	R22E	36	2.20	262	Missouri River	134.0
FEI-30	T22N	R15E	5	0.75	90	Missouri River	53.7
FEI-40	T18N	R16E	28	13.69	1,592	Warm Springs Creek	944.3
FEI-50	T17N	R16E	27	63.48	7,381	Judith River	4,218.3
							7,282.8
Gallatin							
GA-13	T2S	R5E	34	1.34	106	Well	170
GA-14	T2S	R5E	25	0.63	50	Well	80
GA-24	T2S	R5E	5	1.84	146	Well	234
GA-35	T2S	R4E	27	0.63	71	Well	30
GA-40	T2S	R4E	24	0.94	75	Well	120
GA-41	T2S	R5E	36	1.26	100	Well	160
GA-44	T2S	R5E	3	2.20	175	Well	280
GA-46	T2S	R5E	26	1.26	100	Well	160
GA-79	T1S	R5E	9	4.53	509	Well	300
GA-81	T1S	R4E	3	3.47	390	Well	230
GA-92	T3N	R5E	32	0.91	102	Well	60
GA-102	T1N	R1E	8	2.34	250	Jefferson River	100
GA-110	T1N	R4E	22	1.57	113	Well	104
GA-124	T1N	R5E	34	0.71	56	Well	90
GA-130	T1N	R4E	21	2.11	152	Well	140
GA-143	T1N	R5E	28	4.40	474	Well	330
GA-151	T1N	R6E	17	0.45	51	Well	30
GA-201	T2S	R2E	6	118.35	12,249	Madison River	7,890
							10,508
Glacier County							
GL-11	T34N	R8W	32	3.72	472	Cut Bank Creek	277
GL-201	T30N	R9W	21	3.35	220	Whitetail Creek	86
GL-221	T4N	R7W	22	4.37	579	Cut Bank Creek	340
							703
Hill County							
HI-269	T29N	R8E	26	18.82	2,708	Marias River	1,350.1
Jefferson Valley							
JV-17	T5N	R3W	29	1.87	129	Well	170
JV-18	T5N	R3W	33	1.10	76	Well	100
JV-25	T1S	R5W	32	0.53	59	Jefferson River	35
JV-55	T1N	R3W	10	1.86	192	Jefferson River	85
JV-56	T1N	R2W	21	1.21	136	Jefferson River	80
JV-63	T4N	R2W	29	0.82	99	Well	50
JV-80	T3N	R2W	19	0.96	67	Well	80
JV-81	T3N	R2W	31	1.31	159	Well	80
JV-95	T1N	R5W	14	14.43	1,749	Jefferson River	440
JV-201	T2S	R6W	23	80.30	11,022	Jefferson River	4,175
JV-202	T1S	R5W	14	88.90	12,177	Jefferson River	4,950
JV-203	T1N	R2W	26	35.80	5,313	Jefferson River	1,765
JV-204	T2S	R6W	23	7.42	703	Jefferson River	405
							12,415
Judith Basin							
JB-21	T15N	R14E	16	0.22	27	Louse Creek	13
JB-61	T17N	R8E	32	2.15	275	Little Otter Creek	154
JB-111	T17N	R10E	18	0.98	131	McCarthy Creek	74
JB-231	T15N	R13E	26	0.75	92	Well	44
JB-232	T15N	R13E	23	0.75	92	Well	44
JB-261	T14N	R11E	6	3.68	56	Running Wolf Creek	21
JB-281	T17N	R8E	3	0.44	28	Otter Creek	10
JB-309	T13N	R15E	1	0.39	45	Little Trout Creek	23
JBI-2	T14N	R14E	16	13.11	1,615	Judith River	904
JBS-3	T17N	R12E	29	3.26	401	Wolf Creek	225
							1,511
Lewis and Clark County							
LC-11	T10N	R4W	13	0.60	80	UT Ten Mile Creek	30
LC-131	T20N	R6W	2	1.03	151	Elk Creek	60
LC-210	T15N	R3W	21	1.25	148	Missouri River	62

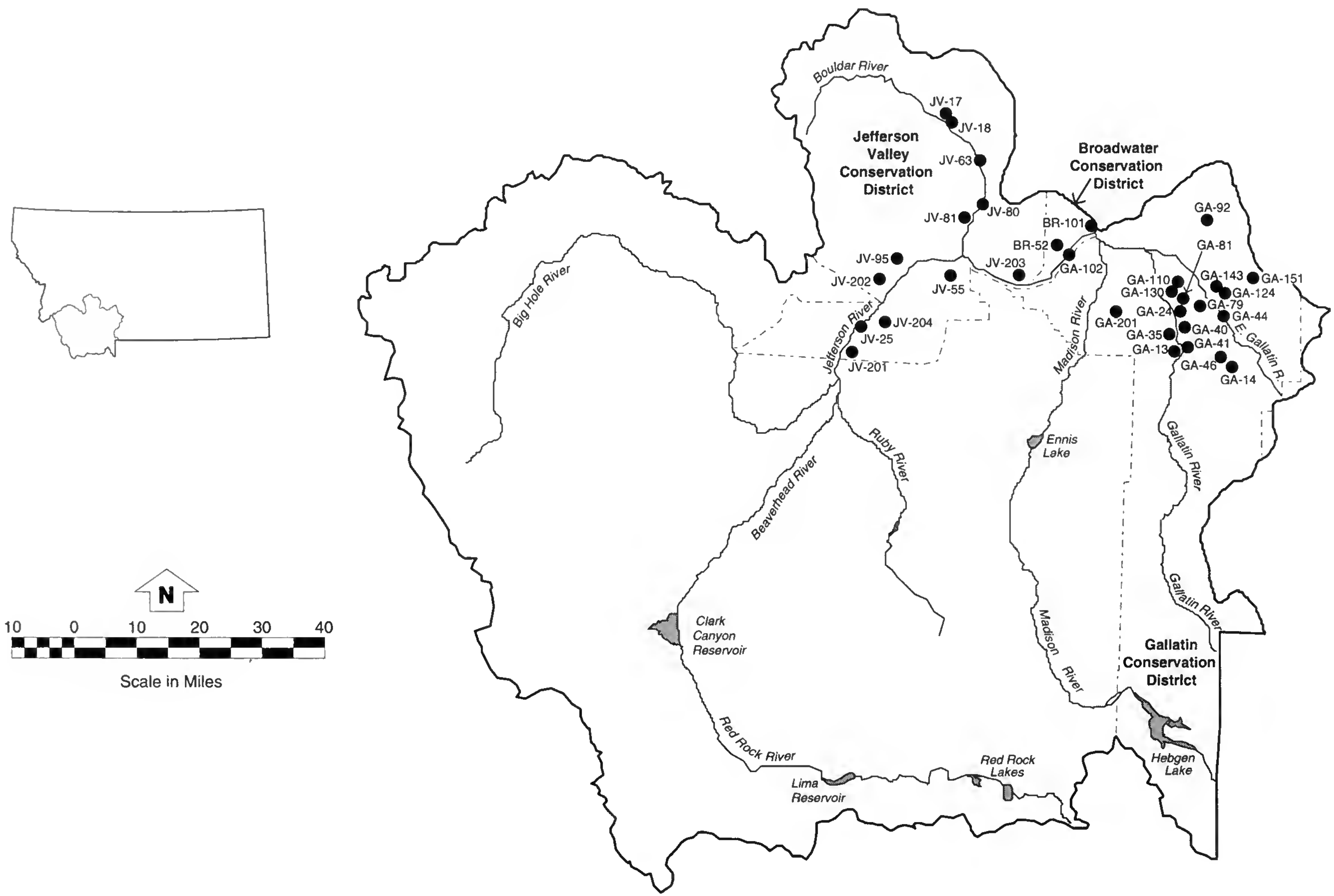
UT - Unnamed tributary

Project Number	Point of Diversion TWN	RGE	SEC	Peak Flow (cfs)	Annual Diversion (af)	Water Source	Project Acres
LC-251	T20N	R6W	25	1.82	281	Smith Creek	130.7
LCI-10	T12N	R2W	11	1.22	185	Upper Holter Lake	81.1
LCI-20	T17N	R5W	25	2.51	355	Dearborn River	173.1
							536.9
Liberty County							
LI-91	T29N	R6E	18	3.49	503	Marias River	251
LI-161	T29N	R5E	3	6.77	1,043	Marias River	450
LI-162	T29N	R5E	11	4.65	690	Marias River	298
LI-261	T29N	R6E	17	24.31	3,241	Marias River	1,614
LI-262	T29N	R7E	21	10.51	1,401	Marias River	697
LI-263	T29N	R7E	27	2.02	269	Marias River	134
							3,444
Lower Musselshell							
LM-10	T19N	R29E	28	100	11,200	Musselshell River, Sand Creek	—[a]
LM-20	T8N	R26E	18	90	8,150	Groundwater, Musselshell River	—
Meagher County							
MEI-11	T9N	R6E	6	10.87	1,247	Smith River	768
MEI-12	T10N	R5E	36	2.22	262	Smith River	166
MEI-20	T10N	R5E	4	2.56	303	Smith River	191
							1,125
Pondera County							
PO-91	T29N	R6W	17	0.99	117	Laughlin Coulee	52
PO-171	T30N	R6W	34	1.81	252	Birch Creek	130
PO-211	T28N	R5W	18	0.98	130	Dry Fork Marias River	58
PO-251	T28N	R10W	23	0.79	94	Birch Creek	42
PO-271	T30N	R4W	7	0.85	112	UT Bullhead Creek	50
PO-411	T30N	R4W	17	2.14	255	UT Bullhead Creek	113
PO-421	T31N	R6W	6	3.21	425	Two Medicine River	249
POI-10	T31N	R7W	5	5.28	707	Two Medicine River	364.3
							1,058.3
Teton County							
TE-81	T25N	R2W	11	0.16	21	Muddy Creek	9.0
TE-101	T26N	R4W	28	1.35	192	Muddy Creek	92.9
TE-181	T22N	R5W	35	3.11	443	Big Coulee	214.8
TE-183	T21N	R4W	5	9.51	1,353	Big Coulee	655.7
TE-281	T26N	R2E	34	0.86	107	Teton River	45.0
TE-282	T25N	R2E	2	1.72	208	Teton River	87.0
TE-321	T24N	R5W	3	6.51	926	Well-Teton River	449.0
TE-361	T24N	R3W	5	2.46	326	Spring Coulee	169.7
TE-401	T24N	R4W	14	2.67	380	UT Teton River, Teton River	184.2
TE-411	T25N	R1W	7	0.89	117	Teton River	49.0
TE-571	T23N	R1W	27	10.52	1,593	Muddy Creek, Sun River	711.0
TE-581	T24N	R4W	1	2.19	297	Gamble Coulee	139.4
TE-591	T24N	R4W	8	11.16	2,500	Gamble Coulee, Teton River	2,236.0
TEI-10	T25N	R2E	4	2.51	358	Teton River	173.3
TEI-20	T25N	R2E	7	1.72	238	Teton River	108.1
TEI-30	T24N	R4W	24	22.44	3,194	Teton River	1,547.8
TEI-40	T24N	R4W	5	0.89	126	Teton River	61.4
TEI-50	T25N	R5W	31	3.45	472	Teton River	229.1
TEI-60	T25N	R6W	31	10.99	1,505	Teton River	729.9
TEI-70	T25N	R7W	31	4.38	600	Teton River	290.4
TEI-80	T21N	R6W	26	1.62	250	Sun River	116.2
TEI-90	T22N	R8W	24	0.83	119	Sun River	55.4
TEI-100	T22N	R8E	32	1.21	173	Sun River	80.8
							8,435.0
Toole County							
TO-211	T30N	R1E	11	10.24	1,476	Tiber Reservoir	735
TO-221	T31N	R2W	28	1.26	153	Marias River	66
TO-341	T31N	R3E	25	3.39	488	Tiber Reservoir	243
TO-342	T31N	R3E	24	3.90	561	Tiber Reservoir	280
TO-421	T29N	R3E	12	0.81	112	Timber Coulee	48
							1,372
Valley County							
VAS-1	T26N	R40E	26	499.11	92,000	Fort Peck Reservoir	25,020

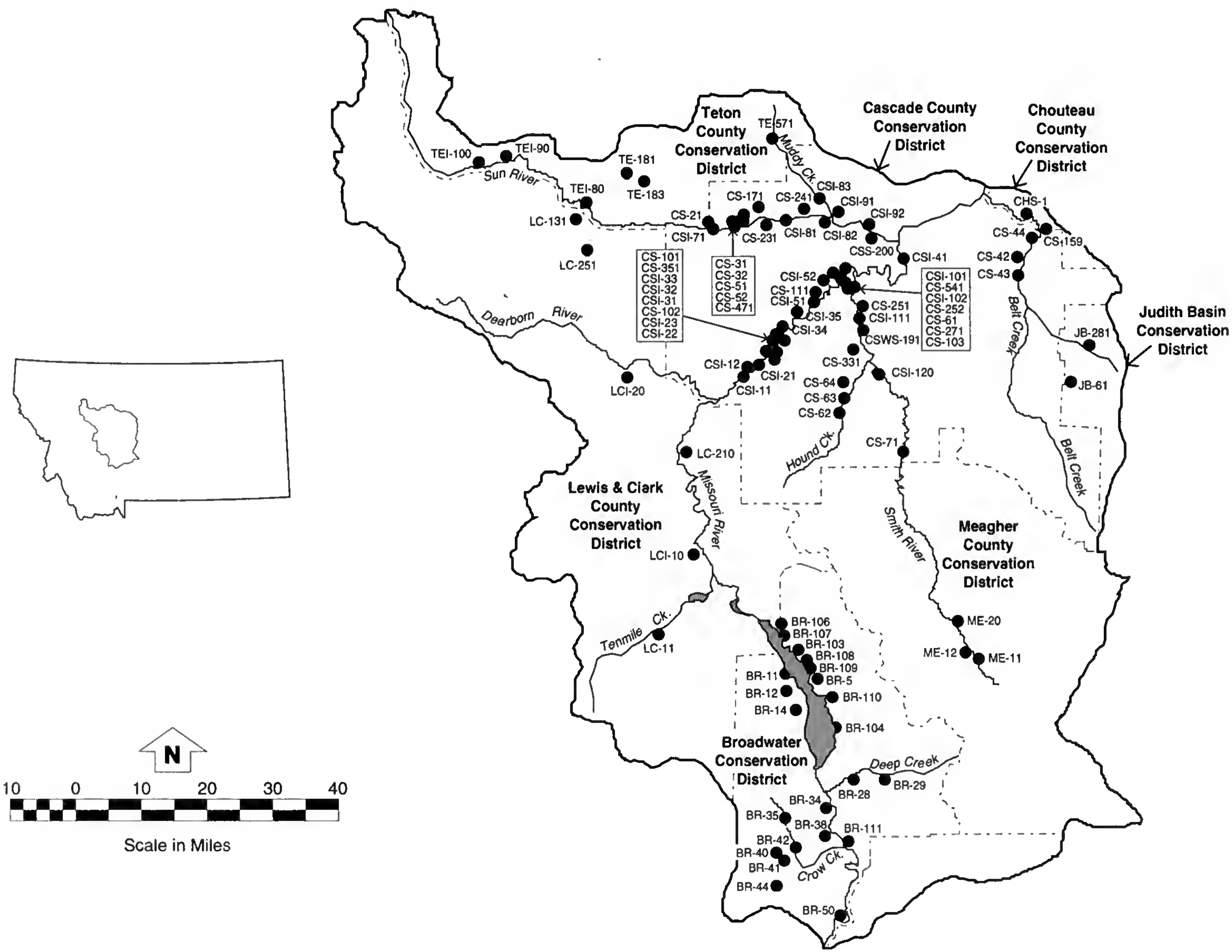
UT - Unnamed tributary

[a] Would supply supplemental water to existing irrigated lands

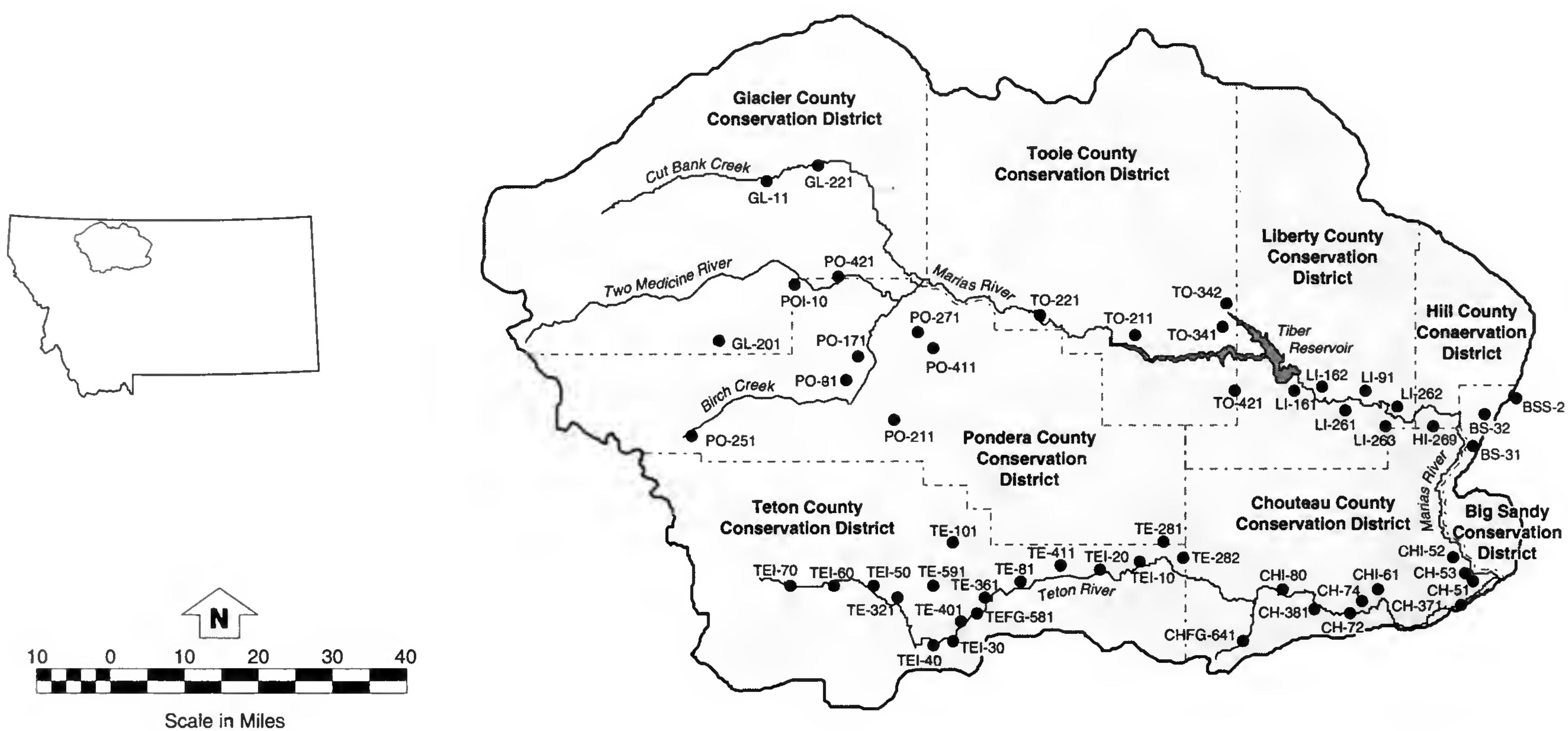
Map 3-2. Proposed conservation district projects in the Headwaters Subbasin



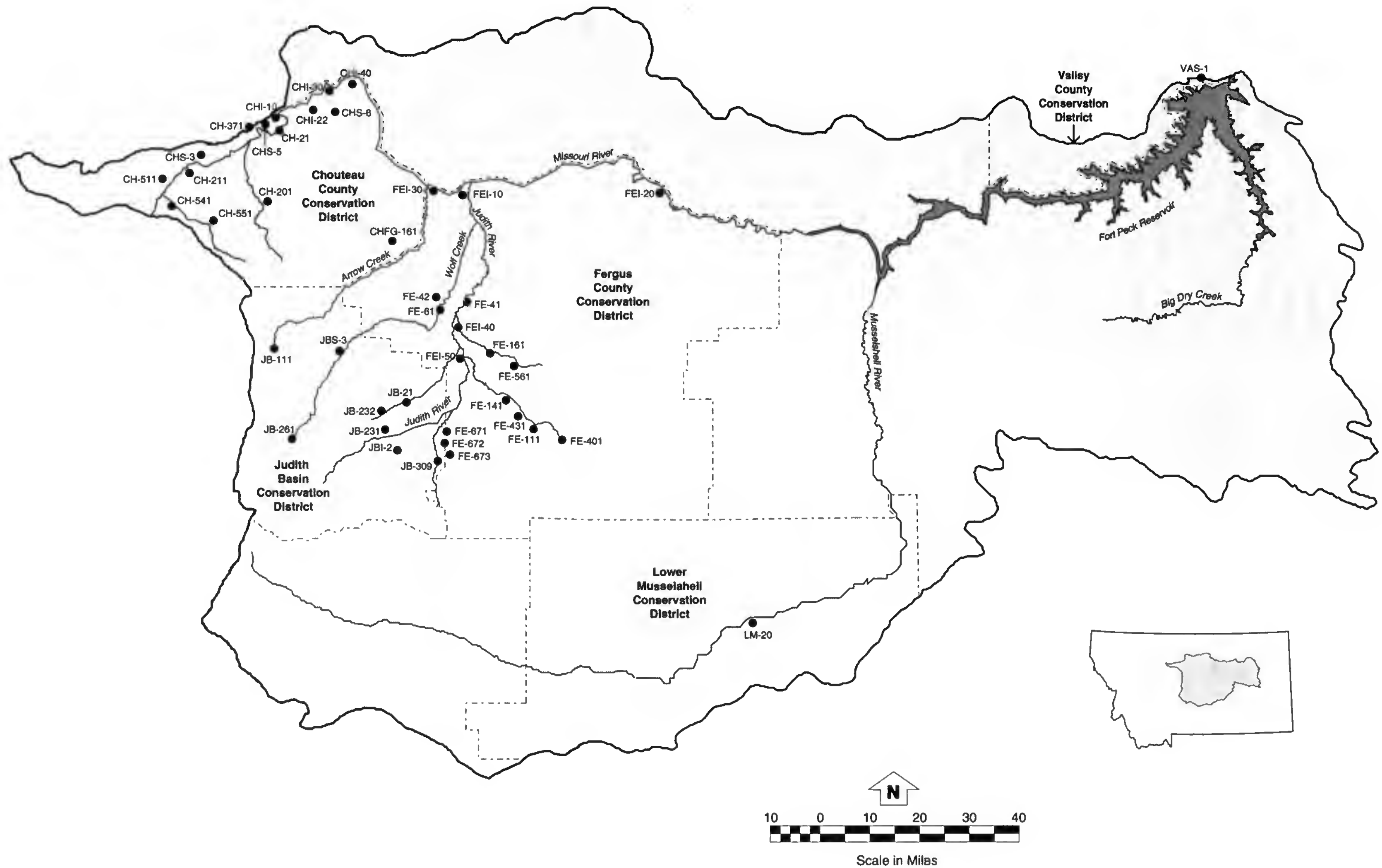
Map 3-3. Proposed conservation district projects in the Upper Missouri Subbasin



Map 3-4. Proposed conservation district projects in the Marias/Teton Subbasin



Map 3-5. Proposed conservation district projects in the Middle Missouri Subbasin



MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS APPLICATION

DFWP's application is intended to maintain water levels adequate for fish, wildlife, and recreation on 283 stream segments, one lake, and one wetland. Requests on some stream segments vary for different parts of the year. The individual reservation requests are summarized in Table 3-2 and shown on Maps 3-6 through 3-9.

PURPOSE

According to DFWP, reserving flows would help protect fish and wildlife habitat; contribute to and maintain a clean, healthful, and desirable environment; and sustain adequate levels of water quality.

NEED

Under Montana statutes, an instream water right for fish, wildlife, and recreational purposes can be obtained only by application for a reservation and not by petition or application for a water use permit. DFWP states that, if the water is not reserved now and is instead allowed to be appropriated for consumptive use, little water may be available for fish and wildlife in the future. DFWP maintains that the reservation of instream flows is necessary to maintain quality angling and other water-oriented recreational opportunities.

DETERMINATION OF AMOUNT

DFWP used several methods to determine the amount of its instream flow requests. A thorough discussion of these methods is presented in DFWP's application. Gauge data were available for some streams, and flows were estimated in others. The Wetted Perimeter Inflection Point Method was used to determine most reservation requests. Several other methods were used in situations where the wetted perimeter method could not be used or where better methods were applicable. A variation of the wetted perimeter method developed by Tennant (1976) was used to derive instream flow requests for 27 high quality stream segments. In segments of 17 high quality spring creeks, the lowest average monthly flow or "base flow" was requested. For seven other stream segments in the Madison and Gallatin watersheds, all remaining unappropriated water was requested. The relationship of stream flows to populations of aquatic organisms was used to determine the instream requests in a few other stream reaches. DFWP's methods are explained in more detail in Appendix B.

PUBLIC INTEREST

According to DFWP, the reservation requests are in the public interest for several reasons. First, the perpetuation of fish and wildlife resources for future use is in the public interest. Second, the reservations would prevent the gradual depletion of streamflows and the diminishment of recreational use by the public. Third, the reserved flows would help to maintain water quality, contributing to a clean and healthful environment for the citizens of the state and nation. Finally, the reservations would contribute to the protection and continued use of existing water rights. DFWP contends existing agricultural water right holders would benefit from instream reservations because of increased legal assurances about the delivery and supply of water for their crops and livestock.

Table 3-2. DFWP instream flow requests

HEADWATERS SUBBASIN

BIG HOLE RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af/yr)
American Creek	Headwaters to mouth	Jan 1 - Dec 31	2.8	2,027
Bear Creek	Headwaters to mouth	Jan 1 - Dec 31	2.8	2,027
Big Hole River #1	Warm Springs Creek to Pintlar Creek	Jan 1 - Dec 31	160	115,835
Big Hole River #2	Pintlar Creek to the old Divide Dam	Jan 1 - Dec 31	800	579,173
Big Hole River #3	Old Divide Dam to mouth	Jan 1 - Dec 31	650	470,578
Big Lake Creek	Twin Lakes outlet to mouth	Jan 1 - Dec 31	4.7	3,403
Birch Creek	Mule Creek to mouth	Jan 1 - Dec 31	10	7,240
Bryant Creek	Headwaters to mouth	Jan 1 - Dec 31	1.4	1,014
California Creek	Headwaters to mouth	Jan 1 - Dec 31	14	10,136
Camp Creek	Headwaters to mouth	Jan 1 - Dec 31	5	3,620
Canyon Creek	Canyon Lake to mouth	Jan 1 - Dec 31	5	3,620
Corral Creek	Headwaters to mouth	Jan 1 - Dec 31	1	724
Deep Creek	Sevenmile and Tenmile to mouth	Jan 1 - Dec 31	18	13,031
Delano Creek	Headwaters to mouth	Jan 1 - Dec 31	0.3	217
Divide Creek	North and East forks to mouth	Jan 1 - Dec 31	3	2,172
Fishtrap Creek	West and Middle forks to mouth	Jan 1 - Dec 31	10	7,240
Francis Creek	Sand Creek to mouth	Jan 1 - Dec 31	4	2,896
French Creek	Headwaters to mouth	Jan 1 - Dec 31	6	4,344
Governor Creek	Headwaters to mouth	Jan 1 - Dec 31	4	2,896
Jacobsen Creek	Tahepia Lake to mouth	Jan 1 - Dec 31	14	10,136
Jerry Creek	Headwaters to mouth	Jan 1 - Dec 31	7	5,068
Johnson Creek	Schultz Creek to Forest Service boundary	Jan 1 - Dec 31	13	9,412
Joseph Creek	Anderson Creek to mouth	Jan 1 - Dec 31	5	3,620
LaMarche Creek	West and Middle forks to mouth	Jan 1 - Dec 31	11	7,964
Miner Creek	Upper Miner Lakes to mouth	Jan 1 - Dec 31	9	6,516
Moose Creek	Headwaters to mouth	Jan 1 - Dec 31	9	6,516
Mussigbrod Creek	Hell Roaring Creek to Forest Service boundary	Jan 1 - Dec 31	10	7,240
NF Big Hole River	Ruby and Trail creeks to mouth	Jan 1 - Dec 31	30	21,719
Oregon Creek	Headwaters to mouth	Jan 1 - Dec 31	0.3	217
Pattengail Creek	Sand Lake to mouth	Jan 1 - Dec 31	12	8,688
Pintlar Creek	Oreamnos Lake to mouth	Jan 1 - Dec 31	10	7,240
Rock Creek	Beaverhead National Forest boundary to mouth	Jan 1 - Dec 31	5	3,620
Ruby Creek	Pioneer and WF Ruby creeks to mouth	Jan 1 - Dec 31	4	2,896
Sevenmile Creek	Headwaters to mouth	Jan 1 - Dec 31	1.8	1,303
Seymour Creek	Upper Seymour Lake to mouth	Jan 1 - Dec 31	13	9,412
Sixmile Creek	Headwaters to mouth	Jan 1 - Dec 31	1.6	1,158
SF Big Hole River	Skinner Lake to mouth	Jan 1 - Dec 31	22	15,927
Steel Creek	Headwaters to mouth	Jan 1 - Dec 31	6	4,344
Sullivan Creek	Headwaters to mouth	Jan 1 - Dec 31	4	2,896
Swamp Creek	Yank Swamp to mouth	Jan 1 - Dec 31	8	5,792
Tenmile Creek	Tenmile Lakes to mouth	Jan 1 - Dec 31	3.8	2,751
Trail Creek	Headwaters to mouth	Jan 1 - Dec 31	14	10,136
Trapper Creek	Trapper Lake to mouth	Jan 1 - Dec 31	3.2	2,317
Twelvemile Creek	Headwaters to mouth	Jan 1 - Dec 31	1.2	869
Warm Springs Creek	West and East forks to mouth	Jan 1 - Dec 31	20	14,479
Willow Creek	Tendoy Lake to mouth	Jan 1 - Dec 31	16	11,583
Wise River	Mono and Jacobson creeks to mouth	Jan 1 - Dec 31	35	25,339
Wyman Creek	Headwaters to mouth	Jan 1 - Dec 31	7	5,068

GALLATIN RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af/yr)
Baker Creek	Heeb Lane Bridge to mouth	Jan 1 - Dec 31	14	10,136
Ben Hart Creek	Headwaters to mouth	Jan 1 - Dec 31	29	20,995
Big Bear Creek	Headwaters to mouth	Jan 1 - Dec 31	2	1,448
Bridger Creek	Headwaters to mouth	Jan 1 - Dec 31	36.6	26,497
Cache Creek	Headwaters to mouth	Jan 1 - Dec 31	2.6	1,882
EF Hyalite Creek	Heather Lake to Hyalite Reservoir	Jan 1 - Dec 31	7	5,068
East Gallatin River #1	Rocky and Sourdough cks to Bozeman STP outlet	Jan 1 - Dec 31	121.3	87,817
East Gallatin River #2	Bozeman STP outlet to Thompson Spring Creek	Jan 1 - Dec 31	90	65,157
East Gallatin River #3	Thompson Spring Creek to mouth	Jan 1 - Dec 31	170	123,074

Ck - Creek   EF - East Fork   R - River   SF - South Fork   STP - sewage treatment plant   WF - West Fork

Gallatin River Drainage (continued)

Gallatin River #1	Yellowstone NP boundary to WF Gallatin River	Jan 1 - Dec 31	170	123,074
Gallatin River #2	WF Gallatin River to East Gallatin River	Jan 1 - Dec 31	400	289,587
Gallatin River #3	East Gallatin River to mouth	Jan 1 - Dec 31	1,000	723,967
Hell Roaring Creek	NF Hell Roaring Creek to mouth	Jan 1 - Dec 31	16	11,583
Hyalite (Middle) Creek #1	Middle Creek Dam to Middle Creek Ditch intake	Jan 1 - Dec 31	28	20,271
Hyalite (Middle) Creek #2	I-90 bridge near Belgrade to mouth	Jan 1 - Dec 31	16	11,583
MF of the WF Gallatin R.	Headwaters to NF of the WF Gallatin River	Jan 1 - Dec 31	3	2,172
Porcupine Creek	NF Porcupine Creek to mouth	Jan 1 - Dec 31	4.5	3,258
Reese Creek	Bill Smith Creek to mouth	Jan 1 - Dec 31	5	3,620
Rocky Creek	Jackson Creek to Sourdough Creek	Jan 1 - Dec 31	51	36,922
Sourdough (Bozeman) Ck.	Mystic Reservoir to mouth	Jan 1 - Dec 31	35.9	25,990
South Cottonwood Creek	Jim Creek to Hart Ditch headgate	Jan 1 - Dec 31	14	10,136
SF Spanish Creek	Falls Creek to mouth	Jan 1 - Dec 31	15	10,859
SF of the WF Gallatin R.	Headwaters to mouth	Jan 1 - Dec 31	5	3,620
Spanish Creek	North and South forks to mouth	Jan 1 - Dec 31	70	50,678
Squaw Creek	Headwaters to mouth	Jan 1 - Dec 31	12	8,688
Taylor Fork	Tumbledown Creek to mouth of Gallatin River	Jan 1 - Dec 31	36	26,063
Thompson Spring Creek	County road crossing in T1N R5E Sec 30 to mouth	Jan 1 - Dec 31	29	20,995
WF Gallatin River	Middle and North forks to mouth	Jan 1 - Dec 31	26	18,823
WF Hyalite Creek	Hyalite Lake to Hyalite Reservoir	Jan 1 - Dec 31	12	8,688

JEFFERSON AND BOULDER RIVER DRAINAGES

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af/yr)
Boulder River #1	West and South forks to High Ore Creek	Jan 1 - Dec 31	20	14,479
Boulder River #2	High Ore Creek to Cold Spring	Jan 1 - Dec 31	24	17,375
Boulder River #3	Cold Spring to mouth	Jan 1 - Dec 31	47	34,026
Halfway Creek	Headwaters to canyon	Jan 1 - Dec 31	1.9	1,376
Hells Canyon Creek	Headwaters to mouth	Jan 1 - Dec 31	3.6	2,606
Jefferson River	Headwaters to Madison River	Jan 1 - Dec 31	1,100	796,363
Little Boulder River	Moose Creek to mouth	Jan 1 - Dec 31	7	5,068
North Willow Creek	Hollow Trap Lake to mouth	Jan 1 - Dec 31	7	5,068
South Boulder River	Curly Creek to mouth	Jan 1 - Dec 31	12	8,688
South Willow Creek	Granite Lake to mouth	Jan 1 - Dec 31	14	10,136
Whitetail Creek	Whitetail Reservoir to mouth	Jan 1 - Dec 31	3	2,172
Willow Creek	North and South Willow creeks to mouth	Jan 1 - Dec 31	14	10,136
Willow Spring Creek	Headwaters to mouth	Jan 1 - Dec 31	9.2	6,660

MADISON RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af/yr)
Antelope Creek	Headwaters to mouth	Jan 1 - Dec 31	14	10,136
Beaver Creek	Wyethia Creek to Earthquake Lake	Jan 1 - Dec 31	937	42,280
Black Sand Spring Creek	Black Sand Spring to SF Madison River	Jan 1 - Dec 31	18.7	13,538
Blaine Spring Creek	Ennis National Fish Hatchery to mouth	Jan 1 - Dec 31	23	16,651
Cabin Creek	Gully Creek to Madison River	Jan 1 - Dec 31	585	28,741
Cherry Creek	Headwaters to mouth	Jan 1 - Dec 31	15	10,859
Cougar Creek	Yellowstone NP boundary to mouth	Jan 1 - Dec 31	24	17,375
Duck Creek	Yellowstone NP boundary to Hebgen Reservoir	Jan 1 - Dec 31	23	16,651
Elk River	Headwaters to mouth	Jan 1 - Dec 31	28	20,271
Grayling Creek	Yellowstone NP boundary to Hebgen Reservoir	Jan 1 - Dec 31	34	24,615
Hot Springs Creek	North and Middle forks to mouth	Jan 1 - Dec 31	5.5	3,982
Indian Creek	Raw Liver Creek to mouth	Jan 1 - Dec 31	48	34,750
Jack Creek	Lone Creek to mouth	Jan 1 - Dec 31	28	20,271
Madison River #1	Yellowstone NP boundary to Hebgen Reservoir	Jan 1 - Dec 31	500	361,983
Madison River #2	Hebgen Dam to West Fork	Jan 1 - Dec 31	800	579,173
Madison River #3	West Fork to Ennis Reservoir	Jan 1 - Dec 31	1,000	723,967
Madison River #4	Ennis Dam to mouth	Jan 1 - Dec 31	1,300	941,157
Moore Creek	Fletcher Creek to mouth	Jan 1 - Dec 31	1.4	1,014
North Meadow Creek	Headwaters to mouth	Jan 1 - Dec 31	18	13,031
O'Dell Creek	Headwaters to mouth	Jan 1 - Dec 31	98	70,949
Red Canyon Creek	Headwaters to Hebgen Reservoir	Jan 1 - Dec 31	2.9	2,100
Ruby Creek	Beartrap Canyon to mouth	Jan 1 - Dec 31	18	13,031
SF Madison River	Dry Canyon to Hebgen Reservoir	Jan 1 - Dec 31	92	66,605
Squaw Creek	North Fork to mouth	Jan 1 - Dec 31	14	10,136
Standard Creek	Headwaters to mouth	Jan 1 - Dec 31	10	7,240
Trapper Creek	Headwaters to Hebgen Reservoir	Jan 1 - Dec 31	3.2	2,317
Watkins Creek	Coffin Creek to Hebgen Reservoir	Jan 1 - Dec 31	5.5	3,982
WF Madison River	Fox Creek to mouth	Jan 1 - Dec 31	957	66,533

Ck - Creek MF - Middle Fork NF - North Fork NP - National Park R - River SF - South Fork WF - West Fork

RED ROCK-BEAVERHEAD DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af/yr)
Bear Creek	Headwaters to BLM boundary	Jan 1 - Dec 31	6.5	4,706
Beaverhead River #1	Clark Canyon to East Bench Div Dam at Barretts	Jan 1 - Dec 31	200	144,793
Beaverhead River #2	East Bench Diversion Dam at Barretts to mouth	Jan 1 - Dec 31	200	144,793
Big Sheep Creek	Cabin and Nicholia creeks to mouth	Jan 1 - Dec 31	48	34,750
Black Canyon Creek	Headwaters to mouth	Jan 1 - Dec 31	2.5	1,810
Blacktail Deer Creek	MF and WF to County Rd @ T8S R8W Secs 20 & 29	Jan 1 - Dec 31	42	30,407
Bloody Dick Creek	Swift Lake outlet to mouth	Jan 1 - Dec 31	20	14,479
Browns Canyon Creek	Headwaters to mouth	Jan 1 - Dec 31	2.3	1,665
Cabin Creek	Headwaters to mouth	Jan 1 - Dec 31	0.4	290
Corral Creek	Headwaters to mouth	Jan 1 - Dec 31	6	4,344
Deadman Creek	Deadman Lake to mouth	Jan 1 - Dec 31	4.5	3,258
EF Blacktail Deer Creek	Headwaters to mouth	Jan 1 - Dec 31	18	13,031
EF Clover Creek	Headwaters to mouth	Jan 1 - Dec 31	4.4	3,185
EF Dyce Creek	Headwaters to mouth	Jan 1 - Dec 31	1.4	1,014
Frying Pan Creek	Headwaters to mouth	Jan 1 - Dec 31	1.6	1,158
Grasshopper Creek	Blue Creek to mouth	Jan 1 - Dec 31	30	21,719
Hell Roaring Creek	Headwaters to mouth	Jan 1 - Dec 31	15	10,859
Horse Prairie Creek	Headwaters to mouth	Jan 1 - Dec 31	36	26,063
Indian Creek	Headwaters to mouth	Jan 1 - Dec 31	0.2	145
Jones Creek	Headwaters to Lakeview Road crossing	Jan 1 - Dec 31	1.9	1,376
Long Creek	Jones Creek to mouth	Jan 1 - Dec 31	3.4	2,461
Medicine Lodge Creek	Bear Canyon to mouth	Jan 1 - Dec 31	10	7,240
Narrows Creek	Spring in T13S R1E Sec18A to Elk Lake	May 1 - July 15	1.2	869
		July 16 - April 30	0.5	362
Odell Creek	Headwaters to Lower Red Rock Lake	Jan 1 - Dec 31	11	7,964
Peet Creek	Headwaters to reservoir in T14S R4W Sec34A	Jan 1 - Dec 31	0.9	652
Poindexter Slough	Springs & canal T8S R9W Sec3,SW to Beaverhead	Jan 1 - Dec 31	57.9	41,918
Rape Creek	Headwaters to reservoir in T10S R13W Sec4	Jan 1 - Dec 31	0.4	290
Red Rock Creek	Headwaters to Upper Red Rock Lake	Jan 1 - Dec 31	15	10,859
Red Rock River #1	Dam at Lower Red Rock Lake to Lima Reservoir	Jan 1 - Dec 31	55	39,818
Red Rock River #2	Lima Dam to Clark Canyon Reservoir	Jan 1 - Dec 31	60	43,438
Reservoir Creek	Headwaters to mouth	Jan 1 - Dec 31	1.5	1,086
Shenon Creek	Headwaters to BLM boundary in T10S R14W Sec25	Jan 1 - Dec 31	0.4	290
Simpson Creek	Headwaters to mouth	Jan 1 - Dec 31	0.7	507
Tom Creek	Headwaters to Upper Red Rock Lake	Jan 1 - Dec 31	1.4	1,014
Trapper Creek	Headwaters to mouth	Jan 1 - Dec 31	0.7	507
WF Blacktail Deer Creek	Grays and South forks to mouth	Jan 1 - Dec 31	3	2,172
WF Dyce Creek	Headwaters to mouth	Jan 1 - Dec 31	0.7	507

RUBY RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af/yr)
Coal Creek	Headwaters to mouth	Jan 1 - Dec 31	3.6	2,606
Cottonwood Creek	Geyser Creek to mouth	Jan 1 - Dec 31	4	2,896
EF Ruby River	Headwaters to mouth	Jan 1 - Dec 31	3	2,172
MF Ruby River	Divide Creek to mouth	Jan 1 - Dec 31	5	3,620
Mill Creek	Outlet of Branham Lake to mouth	Jan 1 - Dec 31	10	7,240
NF Greenhorn Creek	Headwaters to mouth	Jan 1 - Dec 31	3.5	2,534
Ruby River #1	East, Middle, and West forks to Ruby Reservoir	Jan 1 - Dec 31	102	73,845
Ruby River #2	Ruby Dam to mouth	Jan 1 - Dec 31	40	28,959
Warm Springs Creek	Ruby Lake outlet to mouth	Jan 1 - Dec 31	48.5	35,112
WF Ruby River	Headwaters to mouth	Jan 1 - Dec 31	3.0	2,172
Wisconsin Creek	Crystal Lake outlet to mouth	Jan 1 - Dec 31	12	8,688

UPPER MISSOURI SUBBASIN

UPPER MISSOURI RIVER AND TRIBUTARIES

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af/yr)
Avalanche Creek	Cooney Gulch to Canyon Ferry Reservoir	Jan 1 - Dec 31	5	3,620
Beaver Creek	Headwaters in Elkhorn Mts to Canyon Ferry Reservoir	Jan 1 - Dec 31	2.8	2,027
Beaver Creek	Headwaters in Big Belt Mts to mouth	Jan 1 - Dec 31	10.0	7,240
Canyon Creek	Headwaters to mouth	Jan 1 - Dec 31	10.0	7,240
Confederate Gulch	Debauch Gulch to mouth	Jan 1 - Dec 31	5	3,620
Cottonwood Creek	Headwaters to mouth	Jan 1 - Dec 31	1.0	724
Crow Creek	Tizer and Wilson Creeks to Williams Ditch intake	Jan 1 - Dec 31	11	7,964
Deep Creek	Castle Fork to Missouri River	Jan 1 - Dec 31	9	6,516

EF - East Fork MF - Middle Fork NF - North Fork WF - West Fork

Upper Missouri River and Tributaries (continued)

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Dry Creek	Headwaters to Broadwater Missouri Canal	Jan 1 - Dec 31	1.8	1,303	
Duck Creek	Headwaters to Canyon Ferry Res.	Jan 1 - Dec 31	8	5,792	
Little Prickly Pear Ck. #1	Canyon Creek to Clark Creek	Jan 1 - Dec 31	22	15,927	15,927
Little Prickly Pear Ck. #2	Clark Creek to mouth	Jan 1 - Dec 31	70	50,678	50,678
Lyons Creek	Headwaters to mouth	Jan 1 - Dec 31	10.0	7,240	7,240
McGuire Creek	Headwaters to mouth	May 1 - Nov 30	8.3	3,523	
		Dec 1 - Apr 30	4.7	1,408	4,931
Missouri River #1	Jefferson and Madison rivers to Canyon Ferry Res.	Jan 1 - Dec 31	2,400	1,737,520	1,737,520
Missouri River #2	Hauser Dam to Holter Reservoir	Oct 15 - Dec 15	4,878	599,873	
		Dec 16 - Mar 15	3,000	535,537	
		Mar 16 - Apr 30	5,316	485,030	
		May 1 - June 30	7,890	954,624	
		July 1 - Oct 14	3,500	735,867	3,310,931
Missouri River #3	Holter Dam to Great Falls	May 19 - July 5	6,398	609,132	
		July 6 - May 18	4,100	2,577,916	3,187,048
Prickly Pear Creek #1	Rabbit Gulch to Hwy 12 bridge in East Helena	Jan 1 - Dec 31	22	15,927	15,927
Prickly Pear Creek #2	Hwy 12 bridge in East Helena to Lake Helena	Jan 1 - Dec 31	30	21,719	21,719
Sevenmile Creek	Greenhorn Creek and Skelly Gulch to mouth	Jan 1 - Dec 31	1.0	724	724
Silver Creek	Helena Valley Irrigation Canal to mouth	May 1 - Nov 30	13.0	5,518	
		Dec 1 - Apr 30	5.4	1,617	7,135
Sixteenmile Creek	Billy Creek to mouth	Jan 1 - Dec 31	20	14,479	14,479
Spokane Creek	Helena Valley Irr. Canal to mouth	May 1 - Nov 30	4.0	1,698	
		Dec 1 - Apr 30	3.0	898	2,596
Stickney Creek	North and South forks to mouth	Apr 1 - Apr 30	7	417	
		May 1 - May 31	34	2,091	
		June 1 - June 30	35	2,083	
		July 1 - July 31	7	430	5,021
Tenmile Creek	Headwaters to mouth	Jan 1 - Dec 31	12.0	8,688	8,688
Trout Creek	Springs near Vigilante Campground to mouth	Jan 1 - Dec 31	15.0	10,860	10,860
Virginia Creek	Headwaters to mouth	Jan 1 - Dec 31	6.0	4,344	4,344
Wegner Creek	Headwaters to mouth	Apr 1 - Apr 30	8	476	
		May 1 - May 31	41	2,521	
		June 1 - June 30	38	2,261	
		July 1 - July 31	8	492	5,750
Willow Creek	Headwaters to mouth	Jan 1 - Dec 31	3.5	2,534	2,534
Wolf Creek	Headwaters to mouth	Jan 1 - Dec 31	7.0	5,068	5,068

DEARBORN RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Dearborn River	Headwaters to mouth	Jan 1 - Dec 31	110	79,636	79,636
Flat Creek	Headwaters to mouth	Jan 1 - Dec 31	7.5	5,430	5,430
MF Dearborn River	Headwaters to mouth	Jan 1 - Dec 31	9.5	6,878	6,878
Sheep Creek	Headwaters of South Fork to mouth	Jan 1 - Dec 31	22	15,927	15,927
SF Dearborn River	Headwaters to mouth	Jan 1 - Dec 31	11.5	8,326	8,326

SMITH RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Big Birch Creek	Headwaters to mouth	Jan 1 - Dec 31	11	7,964	7,964
Eagle Creek	Headwaters to mouth	Jan 1 - Dec 31	2.5	1,810	1,810
Hound Creek	EF Hound Creek and Middle Creek to mouth	Jan 1 - Dec 31	35	25,339	25,339
Newlan Creek	Headwaters to mouth	Jan 1 - Dec 31	3.8	2,751	2,751
NF Deep Creek	Headwaters to rock cascades	Jan 1 - Dec 31	1.0	724	724
NF Smith River	Headwaters to mouth	Jan 1 - Dec 31	9	6,516	6,516
Rock Creek	Headwaters to mouth	Jan 1 - Dec 31	11	7,964	7,964
Sheep Creek	Headwaters to mouth	Jan 1 - Dec 31	35	25,339	25,339
Smith River #1	North and South Forks Sheep Creek	Jan 1 - Dec 31	90	65,157	65,157

EF - East Fork Irr. - Irrigation MF - Middle Fork Res. - Reservoir SF - South Fork

Smith River Drainage (continued)

Smith River #2	Sheep Creek to Hound Creek	Jan 1 - Dec 31	150	108,595	108,595
Smith River #3	Hound Creek to mouth	Jan 1 - Dec 31	80	57,917	57,917
SF Smith River	Headwaters to mouth	Jan 1 - Dec 31	7	5,068	5,068
Tenderfoot Creek	Headwaters to mouth	Jan 1 - Dec 31	15	10,859	10,859

SUN RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Elk Creek	Headwaters to mouth	Jan 1 - Dec 31	16	11,583	11,583
Ford Creek	Headwaters to mouth	Jan 1 - Dec 31	12	8,688	8,688
NF Willow Creek	Headwaters to mouth	Jan 1 - Dec 31	3.0	2,172	2,172
Sun River #1	Diversion Dam to Elk Creek	Jan 1 - Dec 31	100	72,397	72,397
Sun River #2	Elk Creek to mouth	Jan 1 - Dec 31	130	94,116	94,116
Willow Creek	Headwaters to mouth	Jan 1 - Dec 31	3	2,172	2,172

BELT CREEK DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Belt Creek #1	Headwaters to Big Otter Creek	Jan 1 - Dec 31	90	65,157	65,157
Belt Creek #2	Big Otter Creek to Missouri River	Jan 1 - Dec 31	35	25,339	25,339
Big Otter Creek	Whiskey Spring Coulee to Belt Creek	Jan 1 - Dec 31	5	3,620	3,620
Dry Fork Belt Creek	Galena and Oti Park Creek to Belt Creek	Jan 1 - Dec 31	7	5,068	5,068
Logging Creek	Headwaters to Belt Creek	Jan 1 - Dec 31	6	4,344	4,344
Pilgrim Creek	Headwaters to Belt Creek	Jan 1 - Dec 31	8	5,792	5,792
Tillinghast Creek	Headwaters to Belt Creek	Jan 1 - Dec 31	5.5	3,982	3,982

MIDDLE MISSOURI SUBBASIN

MIDDLE MISSOURI RIVER AND TRIBUTARIES

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Cow Creek	NF and SF to County bridge	Jan 1 - Dec 31	4.5	3,258	3,258
Highwood Creek	Headwaters to Hwy 228 Bridge at Highwood	Jan 1 - Dec 31	10	7,240	7,240
Missouri River #4	Great Falls to Marias River	Mar 15 - May 18	4,887	630,059	
		May 19 - July 5	11,284	1,074,311	
		July 6 - Aug 31	4,500	508,760	
		Sep 1 - Mar 14	3,700	1,431,075	3,644,205
Missouri River #5	Marias River to Judith River	Mar 15 - May 18	5,571	718,244	
		May 19 - July 5	14,000	1,332,892	
		July 6 - Aug 31	5,400	610,512	
		Sep 1 - Mar 14	4,300	1,663,140	4,324,788
Missouri River #6	Judith River to upper end of Fort Peck Reservoir	Mar 15 - May 18	7,100	915,371	
		May 19 - July 5	15,302	1,456,851	
		July 6 - Aug 31	5,800	655,735	
		Sep 1 - Mar 14	4,700	1,817,850	4,845,807
Shonkin Creek	Forest boundary to town of Shonkin	Jan 1 - Dec 31	7	5,068	5,068
FORT PECK RESERVOIR TRIBUTARIES					
Big Dry Creek	Hwy 200 bridge to mouth	Mar 15 - Mar 31	300	9,521	
		Apr 1 - Apr 30	100	5,950	
		May 1 - May 31	35	2,152	
		June 1 - Oct 31	5.5	1,669	19,292
Little Dry Creek	Whiteside ranch house to Big Dry Creek	Mar 15 - Mar 31	110	3,491	
		Apr 1 - Apr 30	42	2,499	
		May 1 - May 31	17	1,045	
		June 1 - Oct 31	3.5	1,062	8,097

JUDITH RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Beaver Creek	West Fork to Cottonwood Creek	Jan 1 - Dec 31	5	3,620	3,620
Big Spring Creek #1	Fish hatchery to Cottonwood Creek	Jan 1 - Dec 31	110	79,636	79,636
Big Spring Creek #2	Cottonwood Creek to mouth	Jan 1 - Dec 31	100	72,397	72,397
Cottonwood Creek	Spring Branch of Cottonwood Ck. to Big Spring Ck.	Jan 1 - Dec 31	4.5	3,258	3,258

Hwy - Highway NF - North Fork SF - South Fork

Judith River Drainage (continued)

East Fork Big Spring Ck.	Headwaters to Big Spring Creek	Jan 1 - Dec 31	7.5	5,430	5,430
Judith River #1	SF and MF to Big Spring Creek	Jan 1 - Dec 31	25	18,099	18,099
Judith River #2	Big Spring Creek to Missouri River	Jan 1 - Dec 31	160	115,835	115,835
Lost Fork Judith River	SF and WF to MF Judith River	Jan 1 - Dec 31	14	10,136	10,136
Middle Fork Judith River	Headwaters to South Fork	Jan 1 - Dec 31	22	15,928	15,928
South Fork Judith River	Headwaters to Middle Fork	Jan 1 - Dec 31	3.5	2,534	2,534
Warm Spring Creek	Springs to Judith River	Jan 1 - Dec 31	110	79,636	79,636
Yogo Creek	Headwaters to MF Judith River	Jan 1 - Dec 31	3	2,172	2,172

MUSSELSHELL RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Alabaugh Creek	Headwaters to mouth	Jan 1 - Dec 31	12	8,688	8,688
American Fork	South Fork to mouth	Jan 1 - Dec 31	5.5	3,982	3,982
Big Elk Creek	Origin of Lebo Fork to mouth	Jan 1 - Dec 31	9.5	6,878	6,878
Careless Creek	Headwaters to Roberts Creek	Jan 1 - Dec 31	2	1,448	1,448
Checkerboard Creek	East and West Forks to mouth	Jan 1 - Dec 31	6	4,344	4,344
Collar Gulch Creek	Headwaters to mouth	Jan 1 - Dec 31	0.6	434	434
Cottonwood Creek	WF, MF, and Loco Creek to mouth	Jan 1 - Dec 31	16	11,583	11,583
Flatwillow Creek	NF and SF to Petrolia Reservoir	Jan 1 - Dec 31	18	13,031	13,031
Musselshell River #1	NF and SF to Deadmans Basin Div	Jan 1 - Dec 31	80	57,917	57,917
Musselshell River #2	Deadmans Basin Div to Musselshell Div	Jan 1 - Dec 31	80	57,917	57,917
Musselshell River #3	Musselshell Diversion Dam at town of Musselshell to mouth	Jan 1 - Dec 31	70	50,678	50,678
NF Musselshell #1	Headwaters to Bair Reservoir	Jan 1 - Dec 31	3	2,172	2,172
NF Musselshell #2	Bair Reservoir to SF Musselshell R.	Jan 1 - Dec 31	16	11,583	11,583
SF Musselshell	Headwaters to North Fork	Jan 1 - Dec 31	30	21,719	21,719
Spring Creek	Headwaters to mouth	Jan 1 - Dec 31	8	5,792	5,792
Swimming Woman Ck.	Headwaters to Cty road crossing 8 linear miles upstream from mouth	Jan 1 - Dec 31	2.5	1,810	1,810

MARIAS/TETON SUBBASIN

MARIAS RIVER DRAINAGE

STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Badger Creek	N and S Badger creeks to Forest/ Blackfeet Reservation Boundary	Jan 1 - Dec 31	60	43,438	43,438
Birch Creek	Swift Reservoir to Hwy 358	Jan 1 - Dec 31	64	46,334	46,334
Cut Bank Creek	Blackfeet Reservation boundary to mouth	Jan 1 - Dec 31	75	54,297	54,297
Dupuyer Creek	Headwaters to mouth	Jan 1 - Dec 31	12	8,688	8,688
Marias River #1	Two Medicine River and Cut Bank Creek to head of Tiber Reservoir	Jan 1 - Dec 31	200	144,793	144,793
Marias River #2	Tiber Dam to Circle Bridge (Hwy 223)	Jan 1 - Dec 31	500	361,983	361,983
Marias River #3	Circle Bridge (Hwy 223) to mouth	Jan 1 - Dec 31	560	405,421	405,421
North Badger Creek	Headwaters to mouth	Jan 1 - Dec 31	14	10,136	10,136
NF Dupuyer Creek	Headwaters to mouth	Jan 1 - Dec 31	12	8,688	8,688
South Badger Creek	Headwaters to mouth	Jan 1 - Dec 31	40	28,959	28,959
SF Dupuyer Creek	Headwaters to mouth	Jan 1 - Dec 31	6	4,344	4,344
SF Two Medicine River	Headwaters to Forest/ Blackfeet Reservation Boundary	Jan 1 - Dec 31	16	11,583	11,583

TETON RIVER DRAINAGE

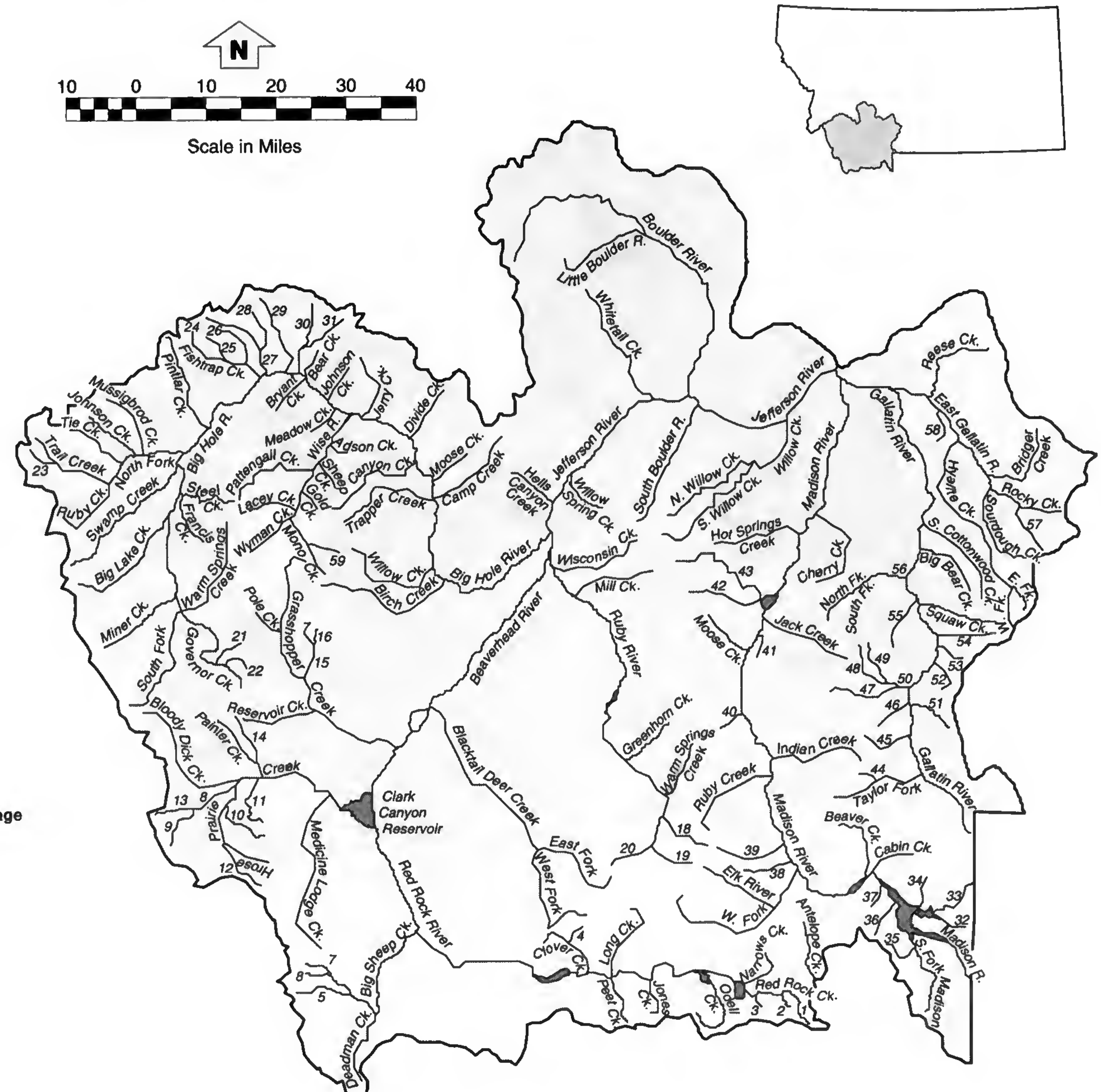
STREAM	REACH DESCRIPTION	DATES REQUESTED	AMOUNT REQUESTED (cfs)	(af)	(af/yr)
Deep Creek	Headwaters to mouth	Jan 1 - Dec 31	18	13,031	13,031
McDonald Creek	Headwaters to mouth	Jan 1 - Dec 31	10	7,240	7,240
NF Deep Creek	Headwaters to mouth	Jan 1 - Dec 31	7.2	5,212	5,212
SF Deep Creek	Headwaters to mouth	Jan 1 - Dec 31	6.9	4,995	4,995
Spring Creek	Headwaters to mouth	Jan 1 - Dec 31	4.5	3,258	3,258
Teton River	Headwaters to discharge from Priest Butte Lake	Jan 1 - Dec 31	35	25,339	25,339

LAKES AND SWAMPS

Bean Lake	Sec. 18C and 19B, T18N, R6W, Sec. 13D and 24A, T18N, R7W	Jan 1 - Dec 31	—	2,649	2,649
Antelope Butte Swamp	North $^1/_2$ Sec. 28, T26N, R8W	Jan 1 - Dec 31	—	460	460

Ck. - Creek Cty - County Div - Diversion Hwy - Highway MF - Middle Fork NF - North Fork R - River SF - South Fork WF - West Fork

Map 3-6. Streams where instream flows have been requested in the Headwaters Subbasin



KEY TO NUMBERED STREAMS

1) Heli Roaring Creek
2) Corral Creek
3) Tom Creek
4) East Fork Clover Creek
5) Simpson Creek
6) Indian Creek
7) Cabin Creek
8) Trail Creek
9) Bear Creek
10) Shenon Creek
11) Rape Creek
12) Black Canyon Creek
13) Frying Pan Creek
14) Browns Canyon Creek
15) Dyce Creek
16) East Fork Dyce Creek
17) West Fork Dyce Creek
18) Cottonwood Creek
19) Coal Creek
20) Middle Fork
21) Fox Creek
22) Andrus Creek
23) Joseph Creek
24) West Fork Fishtrap Creek
25) Middle Fork Fishtrap Creek
26) East Fork Fishtrap Creek
27) LaMarche Creek
28) Middle Fork LaMarche Creek
29) Seymore Creek
30) Deep Creek
31) French Creek
32) Cougar Creek
33) Grayling Creek
34) Red Canyon Creek
35) West Fork Denny Creek
36) Watkins Creek
37) Trapper Creek
38) Soap Creek
39) Standard Creek
40) Blaine Spring Creek
41) O'Dell Creek
42) South Meadow Creek
43) North Meadow Creek
44) Cache Creek
45) Buck Creek
46) Beaver Creek
47) South Fork West Fork Gallatin River
48) Middle Fork West Fork Gallatin River
49) North Fork West Fork Gallatin River
50) West Fork Gallatin River
51) Porcupine Creek
52) Portal Creek
53) Moose Creek
54) Swan Creek
55) Hell Roaring Creek
56) Spanish Creek
57) Bear Canyon Creek
58) Thompson Creek
59) Jacobsen Creek

STREAMS NOT SHOWN

Big Hole Drainage
Sullivan Creek
Twelvemile Creek
Corral Creek
Tenmile Creek
Sevenmile Creek
Sixmile Creek
Oregon Creek
California Creek
American Creek

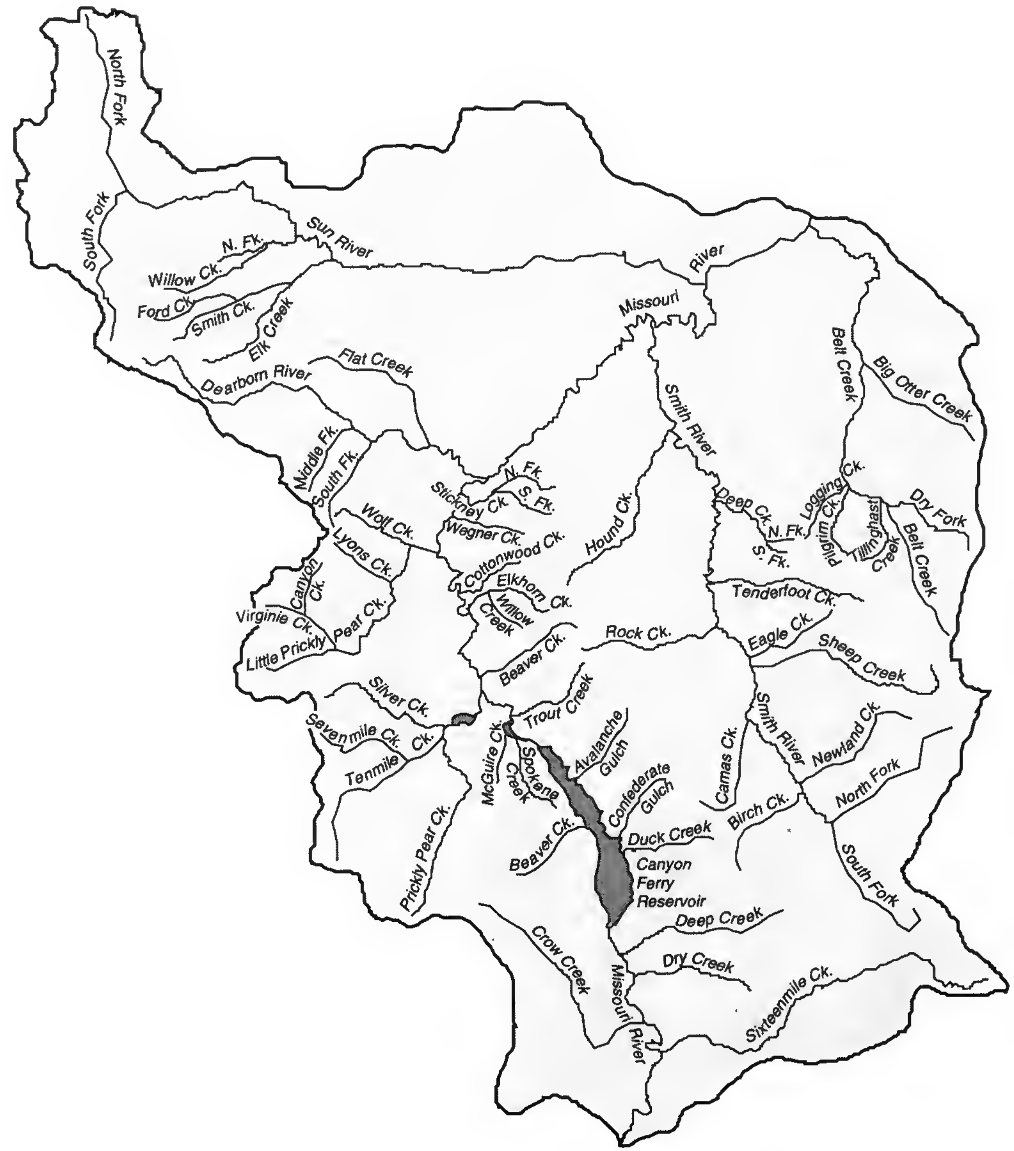
Madison Drainage
Black Sand Spring Creek
Duck Creek

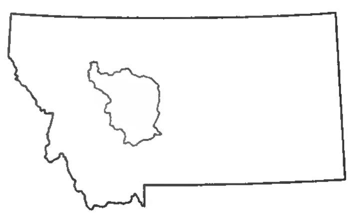
Beaverhead-Red Rock Drainage
Trapper Creek
North Fork Frying Pan Creek
South Fork Frying Pan Creek

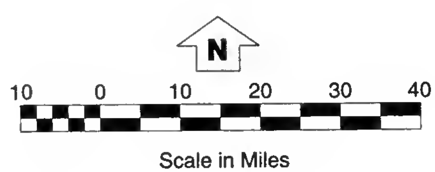
Ruby Drainage
East Fork Ruby River
Corral Creek
West Fork Ruby River

Gallatin Drainage
Baker Creek
Ben Hart Creek

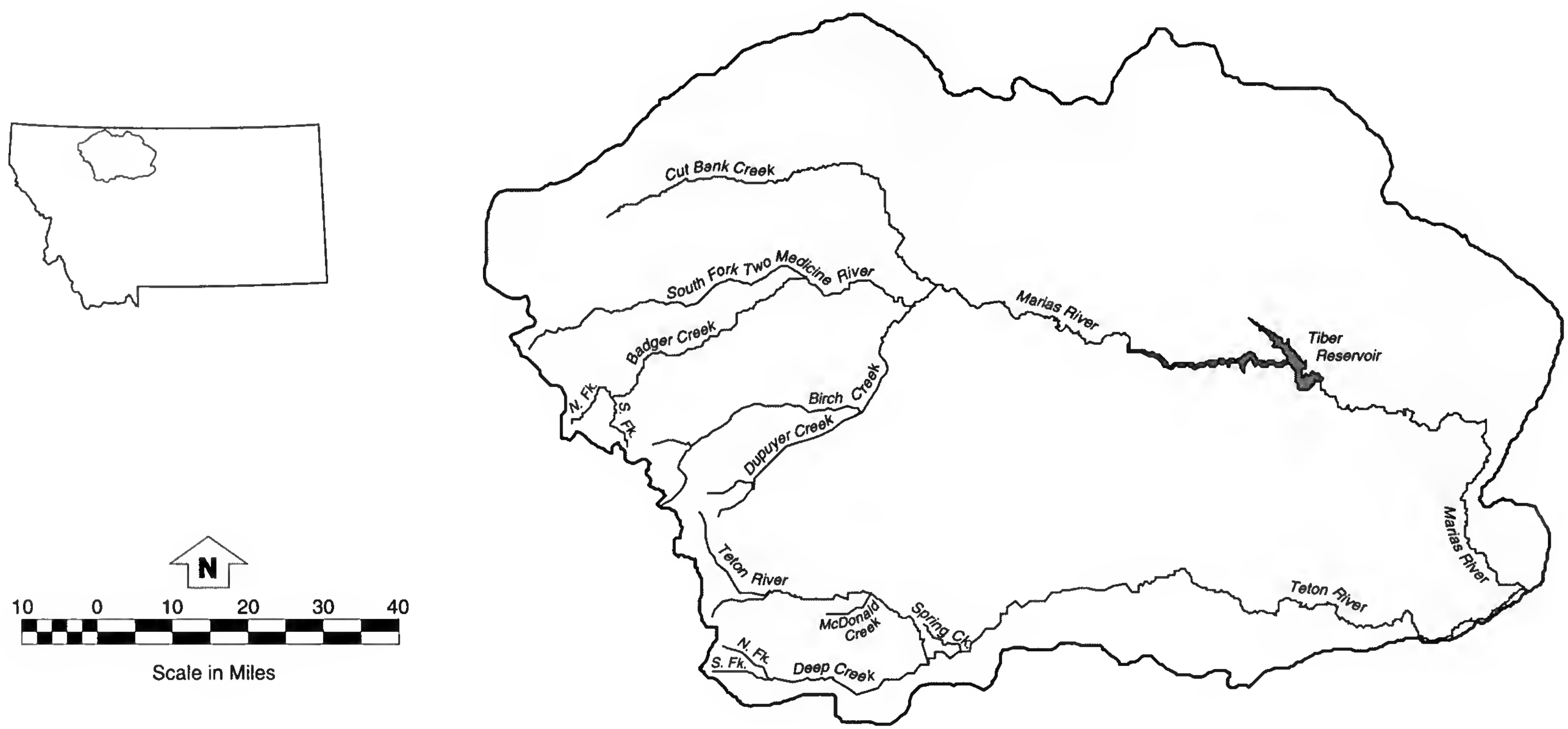
Map 3-7. Streams where instream flows have been requested in the Upper Missouri Subbasin



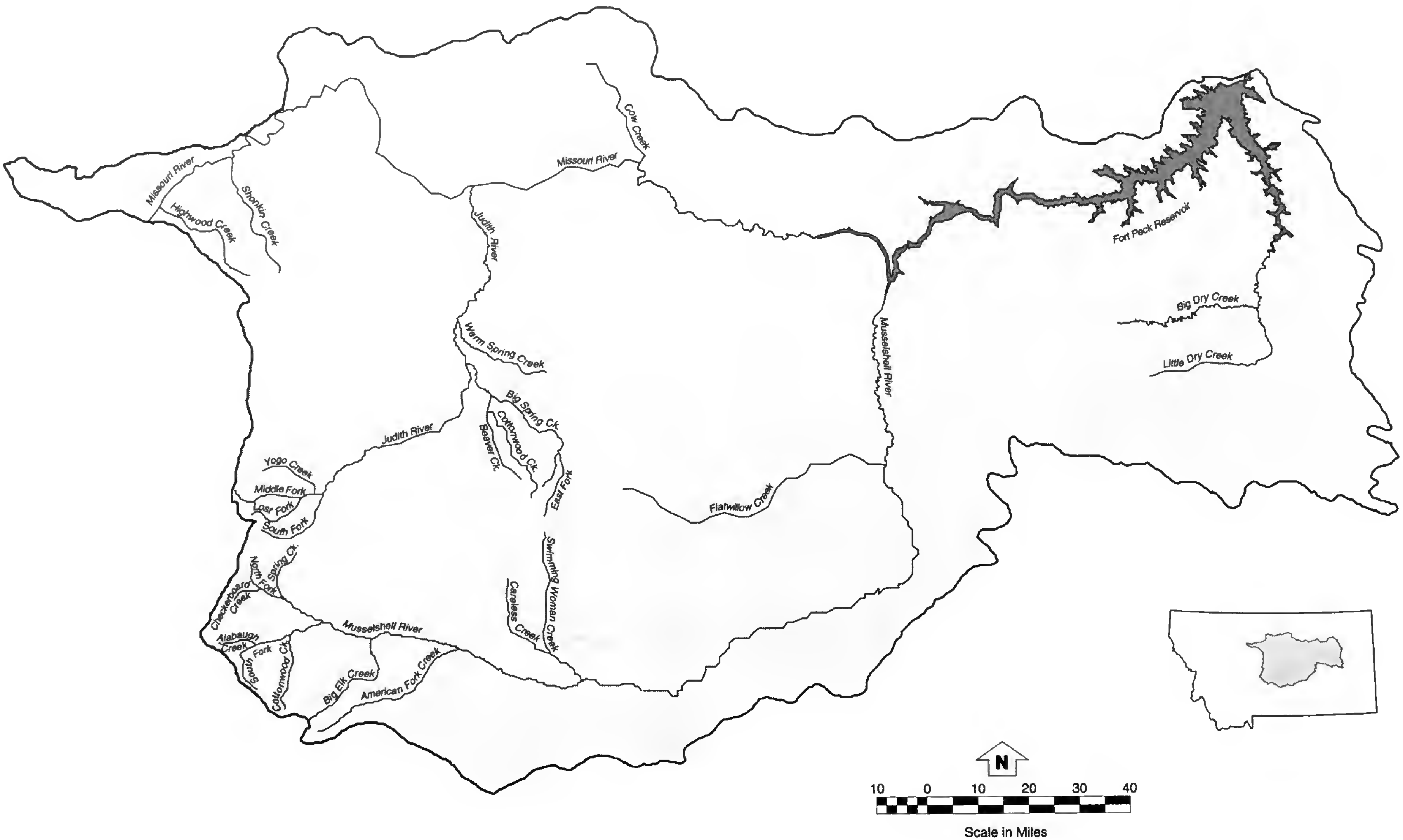




Map 3-8. Streams where instream flows have been requested in the Marias/Teton Subbasin



Map 3-9. Streams where instream flows have been requested in the Middle Missouri Subbasin



MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES APPLICATION

DHES has applied to reserve instream flows to maintain water quality on the main-stem Missouri River. In its application, DHES requests that one-half the average annual flow of the Missouri River be reserved to maintain water quality at the following points: Toston, Ulm, Virgelle, and Landusky (Table 3-3 and Map 3-10).

PURPOSE

DHES seeks to maintain flows in the main-stem Missouri River to dilute naturally occurring arsenic, a carcinogen. Most of this arsenic comes from geothermal springs in Yellowstone National Park, with a lesser contribution from the Boulder River and other tributaries. The reservation would benefit people who rely on the Madison and Missouri rivers and groundwater replenished by these streams for their source of drinking water.

NEED

Present concentrations of arsenic in the Madison River, Boulder River, and Missouri River main stem far exceed the instream standard under the Clean Water Act. DHES contends that significant risks are associated with drinking this water because of the carcinogenic effects of arsenic. Many people in the Missouri basin use surface water or shallow, streamside wells as their drinking water sources. According to DHES, the reservation would help limit increases in arsenic concentrations by ensuring that needed dilution flows are protected from future appropriation. Appropriations from Madison and Missouri tributaries reduce the amount of water in these streams and increase the concentration of arsenic in the remaining water. DHES argues that withdrawal and consumptive use of water from the Missouri River main stem will increase the concentration of arsenic in return flows and eventually the Missouri River.

DETERMINATION OF AMOUNT

In determining the amount of water required for the reservation, DHES assumed that the flow of arsenic from Yellowstone Park is relatively constant. Given this constant output of arsenic, the concentration of arsenic at any downstream point will depend on reservoir operations and the inflow of dilution water from higher quality tributaries. Arsenic measurements taken at different gauging stations along the system were used to estimate the average daily load of arsenic in the Madison and Missouri rivers. DHES said all of the remaining unappropriated water is needed to protect the public health in the basin. However, Section 85-5-331, MCA, limits instream reservations to one-half of the average annual flow of gauged streams. DHES is therefore requesting one-half the average annual flow at four points along the Missouri main stem (Table 3-3). In order to satisfy these requests, sufficient flows would have to remain in the tributaries.

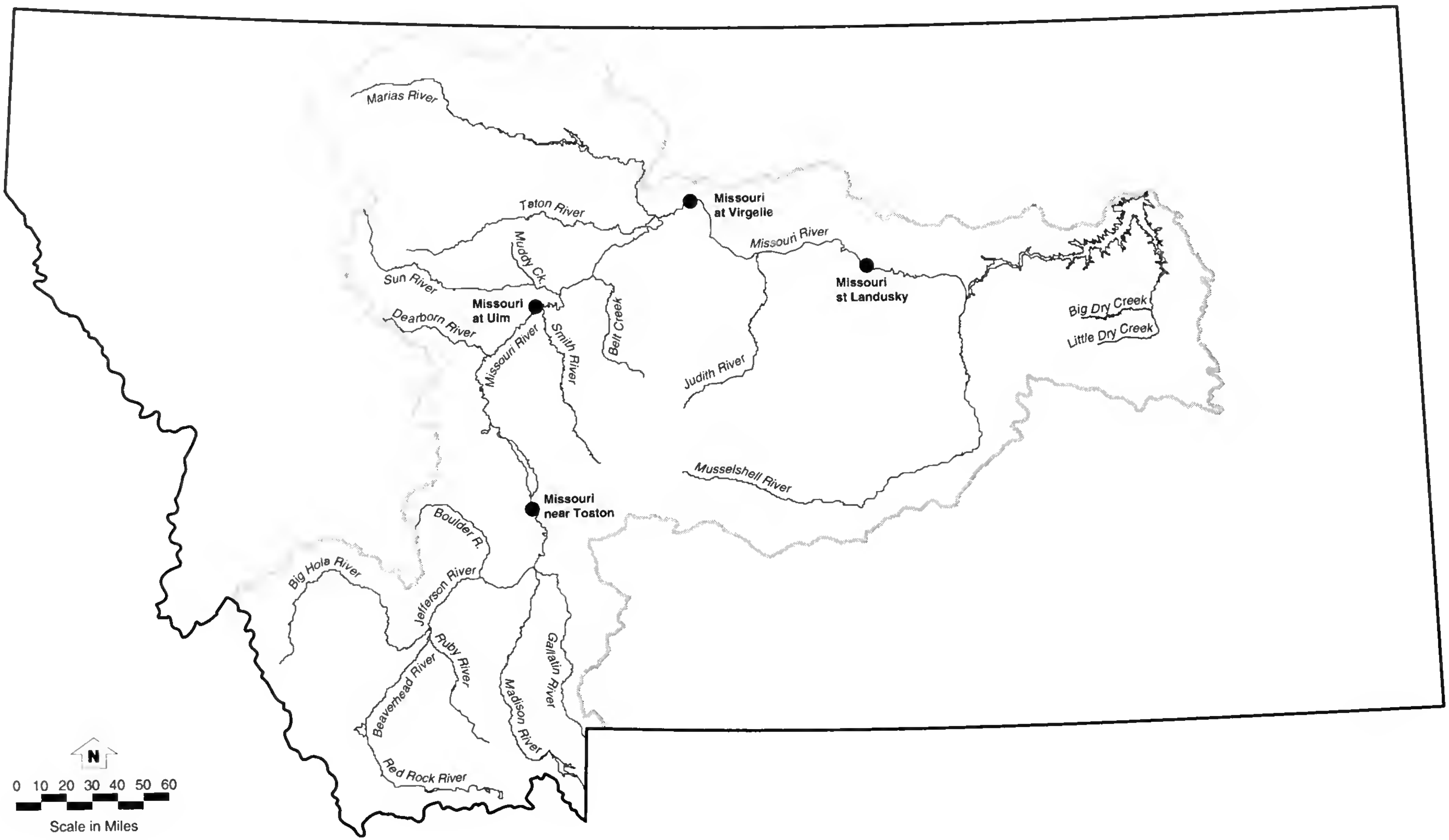
PUBLIC INTEREST

According to DHES, the reservation request is in the public interest for a number of reasons. First, by limiting withdrawals of additional water, the reservation would help limit the increased risk of cancer to people drinking water from the Madison or Missouri rivers or from aquifers recharged by these streams. Second, the reservation would help limit further contamination of soil, groundwater, and crops by water with high arsenic concentrations. Third, the maintenance of water quality contributes to a clean and healthful environment for the state and the nation. The reservation also would contribute to the protection and continued use of existing water rights.

Table 3-3. Amounts requested by DHES to protect water quality

	Amount	
Stream	cfs	acre-feet/year
Missouri River at Toston	2,596	1,879,504
Missouri River at Ulm	3,204	2,319,696
Missouri River at Virgelle	4,390	3,178,360
Missouri River at Landusky	4,815	3,486,060

Map 3-10. Points on the Missouri River where DHES has applied to reserve water



MUNICIPAL APPLICATIONS

Eighteen municipalities have applied to reserve water in the basin for domestic, community, and commercial needs. The reservation requests encompass a variety of projects in the individual communities and pertain to both surface water and groundwater sources. The reservation requests of each community are presented in Table 3-4 and shown on Map 3-11.

PURPOSE

The purpose of the municipal reservation requests is to reserve water for future municipal uses, including domestic water supplies; irrigation of lawns, parks, and city grounds; and commercial and industrial uses. Securing water reservations would help ensure that water would be available for future growth. In some instances, communities are requesting new water supplies due to problems with present sources, such as poor water quality and unreliable supply. The beneficiaries of municipal reservations would be the residents and businesses in the communities served by the municipal water supply systems.

NEED

Because the municipalities feel that water use in the Missouri River basin is continually increasing, they believe they need to reserve water to accommodate future growth. A reservation is the only means of obtaining water for needs that will occur in the future. The possibility of future conflicts with other water users such as downstream states and the federal government is a further reason for communities to obtain reservations.

DETERMINATION OF AMOUNT

Although different municipalities used different methods for determining how much water to request, some general procedures were used by all the municipal applicants. Each town forecast its future population, usually to the year 2025, and determined what future water needs would be, using the estimated amount of water used per person. In most cases, the future needs of the city and service areas outside the city were compared to the amount of water that could be supplied under existing water rights. Potential sources and storage, supply, treatment, distribution, and discharge facilities also were identified and evaluated in each community's application.

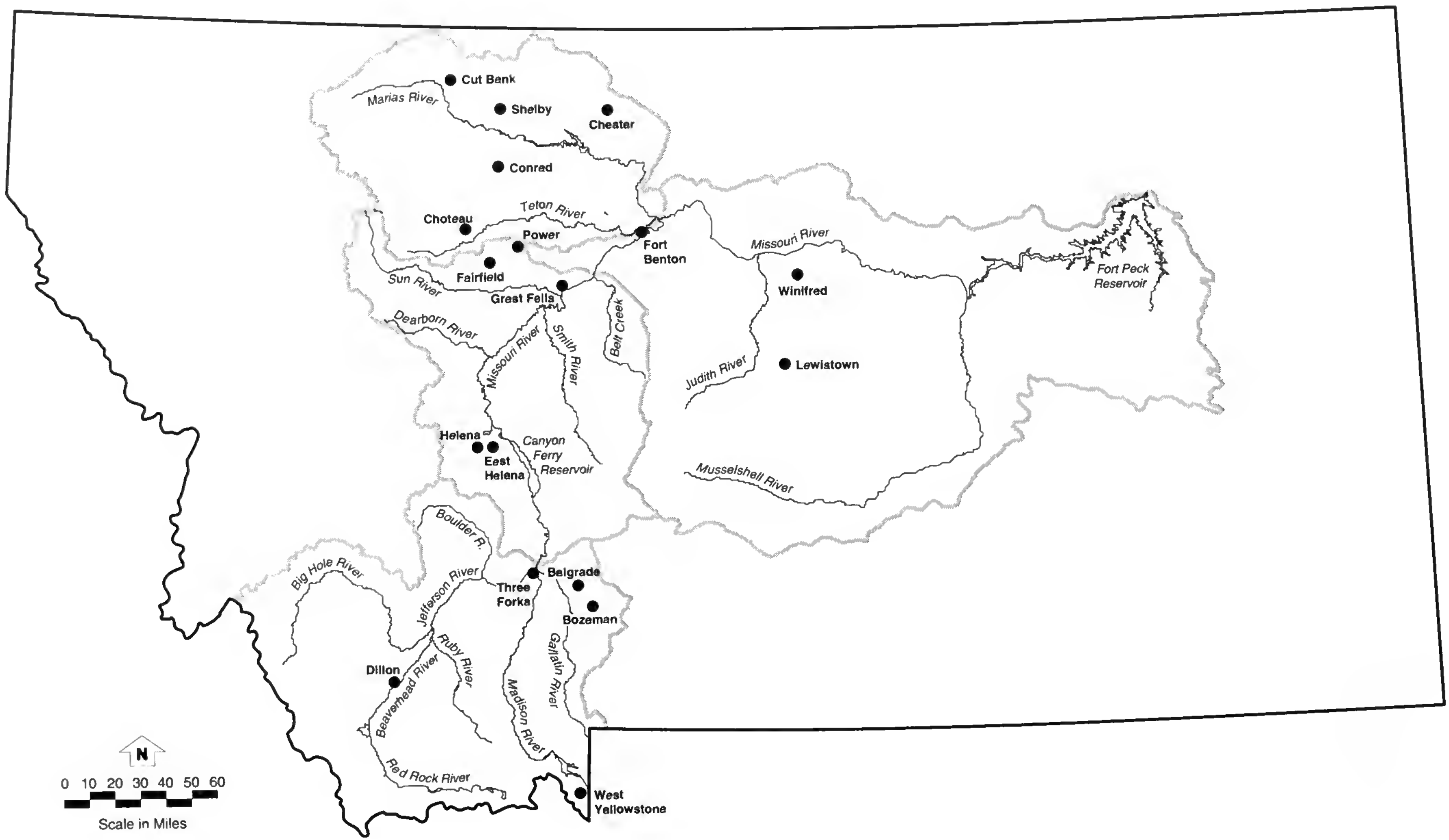
PUBLIC INTEREST

According to the municipalities, the reservation requests are in the public interest for two primary reasons. First, there is constitutional and legislative support for reservation and subsequent acquisition of water for municipal use. Second, it is essential that cities secure an adequate, stable water supply for future development.

Table 3-4. Reservations requested by municipalities

Municipality	Source	—Amount— cfs	acre-feet/ year
Belgrade	Wells (2)	3.56	645
Bozeman	Sourdough (Bozeman) Creek	327.00	6,000
Chester	Marias River	1.00	435
Choteau	Wells (4)	1.84	482
Conrad	Lake Frances (inactive pool)	5.45	1,322
Cut Bank	Cut Bank Creek	3.37	890
Dillon	Well	1.11	202
East Helena	McClellan Creek and wells	0.93	258
Fairfield	Wells (2)	0.34	100
Fort Benton			
Municipal	Missouri River	0.76	89
Parks Irrigation	Missouri River	0.67	35
Great Falls			
Municipal	Missouri River	28.16	10,642
Parks Irrigation	Missouri River	4.45	233.5
Parks Irrigation	Sun River	4.45	233.5
Helena	Wells (6-8)	16.4	7,071
Lewistown	Big Spring Creek	3.57	2,966
Power	Muddy Creek	0.27	62
Shelby	Wells (4-8)	1.83	302
Three Forks	Wells (2)	0.45	81
West Yellowstone	Whiskey Spring	3.53	2,550
Winifred	Well	0.26	60

Map 3-11. Municipalities that have applied to reserve water in the basin



U.S. BUREAU OF LAND MANAGEMENT APPLICATION

BLM applied to reserve water for instream flows on 31 stream reaches in the Headwaters Subbasin that pass through land administered by the agency (see Table 3-5). These streams are also shown on Map 3-6.

PURPOSE

BLM seeks reservations on small headwater tributaries for fish, wildlife, and recreation. The reservation requests are intended to protect these resources.

NEED

Because most of the stream segments included in the application have private land located upstream and downstream from BLM land, the flows in the streams are subject to future appropriations over which BLM has no control. Under Montana law, instream flows can be protected only through the reservation process. All of the streams for which reservations are requested provide important fisheries or wildlife habitat, and a reservation would help to protect these resources. Some of the streams occur in wilderness study areas, and their native plants and animals must be protected until it is decided how they will be managed. Reserving flow would also protect associated riparian habitat that supports diverse recreational opportunities.

DETERMINATION OF AMOUNT

The amount of water needed for the individual streams was considered to be the amount necessary to maintain the channel and provide at least the minimum flow needed for aquatic habitat, wildlife, and recreation. Because none of the stream reaches were gauged, monthly flows for the streams were calculated from data obtained on similar gauged streams in western Montana. BLM determined the acceptable flows on the basis of DFWP's wetted perimeter method (Appendix B). BLM believes that the requested flows would provide the minimum amount of streamflow necessary to maintain aquatic habitat.

BLM is also requesting channel maintenance streamflows. The streamflows requested are equivalent to bankfull discharges and are considered necessary to maintain the form and characteristics of the stream channel. Bankfull discharges were estimated with indirect channel geometry methods developed by the U.S. Geological Survey (1983). The high springtime flow that occurs once every two years on the average (the two-year recurrent peak discharge) was found to closely approximate the bankfull discharge. Accordingly, channel maintenance flows are requested between May 1 and June 30, once every two years.

PUBLIC INTEREST

According to BLM, the reservations would provide a direct benefit to people who hunt, fish, hike, and camp on public land. Because there is access across public land to most of the streams named in the BLM application, a significant amount of recreational use occurs on these streams. The flows also would maintain the highly productive riparian zones on the streambanks, which would protect the stream's fisheries and provide forage and cover for a wide variety of animals. The economic value of the recreational opportunities associated with these streams is also significant.

Table 3-5. Reservations requested by BLM for maintenance of aquatic habitat and stream channels

Stream	Amount: Year-round for aquatic habitat maintenance, cfs	Amount: Year-round for aquatic habitat maintenance, acre feet/year	Amount: Peak discharge every other year for channel maintenance, cfs
Bear Creek near Grant	6	4,344	50
Bear Creek near Wise River	2.5	1,810	50
Big Sheep Creek near Dell	40	28,960	300
Black Canyon Creek near Grant	2.5	1,810	35
Bloody Dick Creek near Grant	20	14,500	270
Cabin Creek near Dell	1	724	4
Canyon Creek near Divide	5	3,620	110
Camp Creek near Melrose	5	3,600	50
Corral Creek near Lakeview	2.5	1,810	20
Deadman Creek near Dell	4.5	3,258	50
Deep Creek near Wise River	30	21,720	500
East Fork Blacktail Deer Creek near Dillon	18	13,032	215
East Fork Dyce Creek near Dillon	1.5	1,086	9
Frying Pan Creek near Grant	1.5	1,086	35
Hell Roaring Creek	15	10,860	250
Indian Creek near Dell	1	724	5
Jones Creek near Lakeview	2	1,428	20
Long Creek near Lakeview	5	3,620	110
Medicine Lodge Creek near Grant	9	6,516	50
Moose Creek near Divide	8	5,800	70
North Fork Greenhorn Creek near Alder	3.5	2,534	35
Odell Creek near Lakeview	11	7,964	225
Peet Creek near Lakeview	1.5	1,090	30
Rape Creek near Grant	1	724	5
Shenon Creek near Grant	1	724	13
Simpson Creek near Dell	1	724	5
Tom Creek near Lakeview	2	1,448	25
Trapper Creek near Grant	1	724	10
West Fork Blacktail Deer Creek near Dillon	3	2,172	25
West Fork Dyce Creek near Dillon	1	724	5
Willow Creek near Glen	12	8,900	130

U.S. BUREAU OF RECLAMATION APPLICATION

BUREC has applied to reserve flows in the Missouri River near Virgelle for diversion to the Milk River near Havre, Montana. The water would be pumped out of the Missouri River through a pipeline and into a canal where it would flow by gravity to the point of discharge (Map 3-12). The amount of water requested is 280 cfs from April 1 to October 30 for a total volume of 89,000 af per year.

PURPOSE

BUREC would reserve water for the following purposes:

1. Supplemental irrigation water (46,400 acre-feet) for 33,000 acres along the Milk River
2. Supplemental irrigation water (10,000 acre-feet) for 14,000 acres on the Fort Belknap Indian Reservation
3. New full service irrigation (5,800 acre-feet) for 3,300 acres on Rocky Boys Indian Reservation
4. New full service irrigation (5,900 acre-feet) for 3,300 acres along the proposed canal between the Missouri and Milk rivers
5. 13,000 acre-feet for Lake Bowdoin National Wildlife Refuge
6. 7,500 acre-feet for BLM stock ponds
7. 400 acre-feet for the town of Chinook

This reservation is the third phase of a three-phase plan to alleviate water shortages in the Milk River and would be implemented only if the other phases are not completely successful. The first phase is under way and involves rehabilitating the St. Mary Canal, which diverts water from the St. Mary River to the Milk River. The second phase involves rehabilitating existing facilities owned by irrigation districts along the Milk River and improving on-farm water use efficiencies.

NEED

BUREC says the need to reserve the water results from (1) the threat to future water availability in the Milk River basin as a result of enforcement of existing water rights, and (2) the desire to improve long-range planning in the Missouri and Milk river basins. If water users in the Milk River basin are to be assured of an adequate supply of water for their projected uses, the flows must be protected from other appropriators. Also, the reservation would reduce water shortages in the Milk River basin and offset shortages of water for supplying federal reserved water rights.

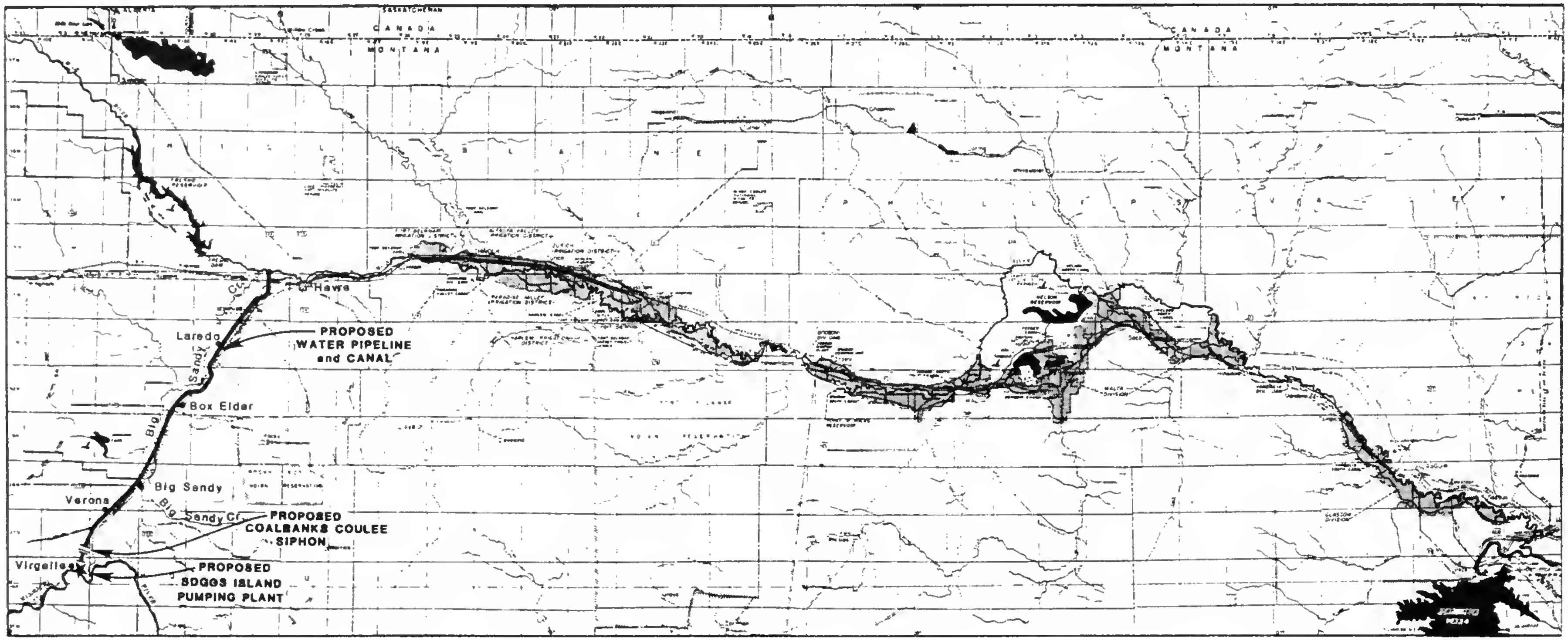
DETERMINATION OF AMOUNT

The amount of water requested was determined by calculating the amount needed to meet the purposes stated above. Detailed information concerning the proposed land and water requirements can be found in the *Milk River Water Supply Study* (DNRC and BUREC undated), which serves as a support document for BUREC's reservation application.

PUBLIC INTEREST

According to BUREC, the reservation request is in the public interest for four reasons. First, there is legislative support for the reservation of water for the beneficial uses included in this reservation request. Second, the reservation application serves to identify consumptive uses for currently unappropriated water. Third, the reservation would maintain existing irrigation in the Milk River basin and also provide for new irrigation with resulting economic benefits. Fourth, the reservation would provide water to Indian tribes, allowing them to develop and maintain an expanded economic base.

Map 3-12. Proposed Bureau of Reclamation diversion project



KEY

Proposed water pipeline

Proposed water canal

Existing Irrigation

N

10 0 10 20 30

Scale in Miles

CHAPTER FOUR

AFFECTED ENVIRONMENT

This chapter includes a description of the existing environment within the Missouri River basin above Fort Peck Dam, the region that would be affected by the requested reservations.

WATER QUANTITY AND DISTRIBUTION

The following section describes the various factors that influence streamflow and the uncertainties inherent in the methods used to estimate existing flows. The baseline streamflow conditions for each of the four subbasins are described. DNRC also developed a computer model to examine water availability in the basin. The model predicts streamflows in the basin assuming irrigation development at 1986 levels. The model is explained in more detail in Appendix C.

NATURAL AND ALTERED FLOW PATTERNS

The natural monthly streamflow patterns in the basin are largely determined by mountain snowmelt and spring rains, which bring flows to their peak in May and June. Flows diminish throughout the summer, fall, and winter months, usually reaching their minimum in March and April. During this time, flows are maintained primarily by groundwater discharges into streams, with an occasional increase in runoff from rainstorms and snowmelt during warm spells in the winter. Streams that originate at lower elevations exhibit a similar pattern, but are controlled more by rain and groundwater inflows.

Natural flow patterns are altered by human activities—primarily irrigation, reservoir operations, and, to a smaller degree, municipal water use. Figure 4-1 illustrates water consumption by the major water users in the basin. The irrigation of approximately 1,244,000 acres between the headwaters and Fort Peck Dam alters streamflow throughout the basin (BUREC 1990).

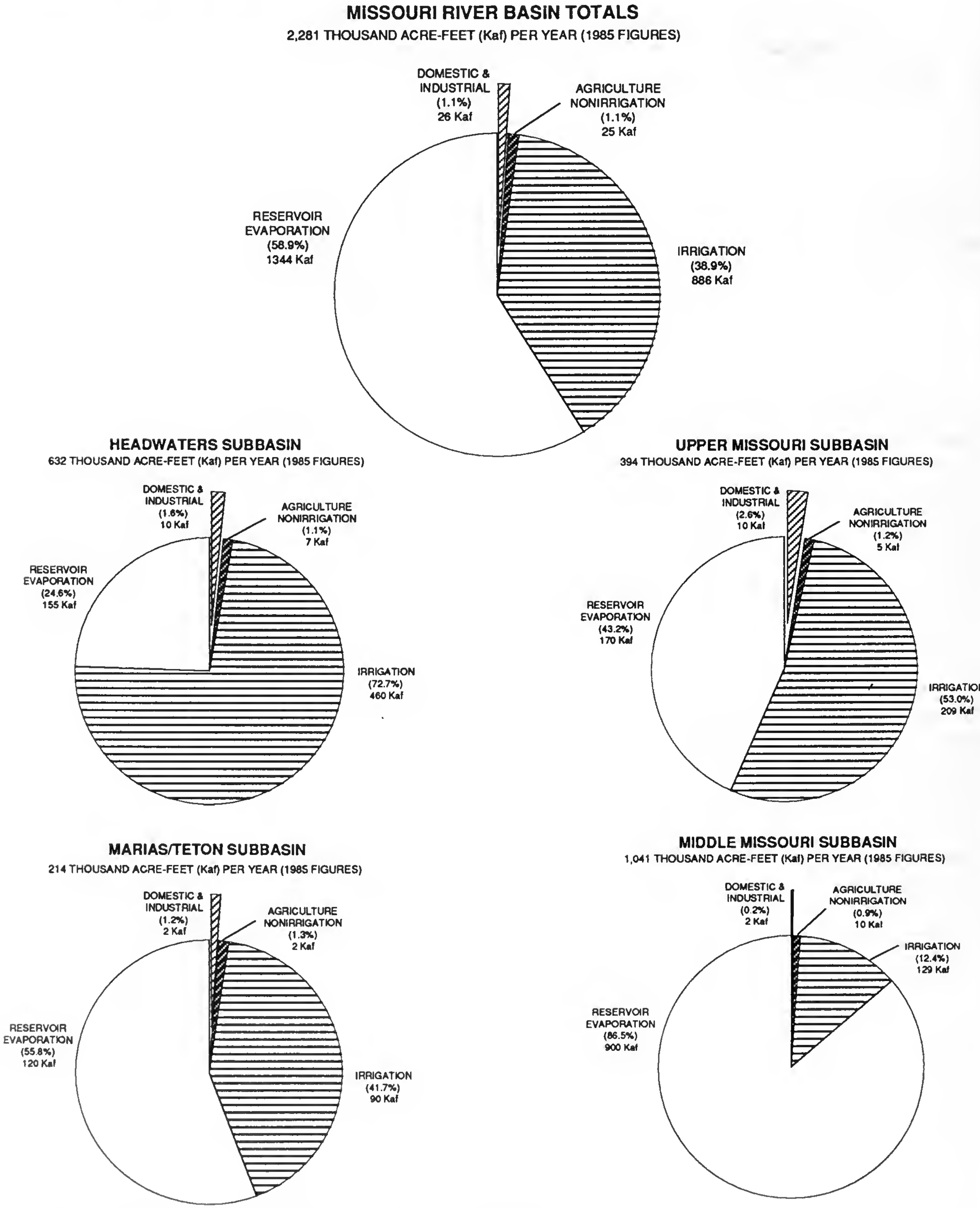
Irrigation usually reduces monthly streamflows in May through early September, and return flows often increase flows from October to February. Figure 4-2 contrasts natural streamflows with streamflows reduced by irrigation. Relative increases and decreases of streamflows depend on site-specific factors such as the amount of water withdrawn, type of irrigation system, irrigation management, crop and soil types, drainage system layout, and soil characteristics. Less efficient irrigation systems, such as flooding, require relatively large amounts of water, much of which returns to the stream. In contrast, more efficient irrigation systems, such as sprinklers, require less water to be diverted, and the amount returned to the stream is also less.

Irrigated crops in Montana typically consume less than 25 percent of the water diverted (SCS 1978). The remaining irrigation water is either evaporated, used by other plants, or returned to the stream as surplus canal flow, surface runoff, or groundwater. Water returning to the stream may be used by others.

Municipalities alter streamflows in much the same way as irrigation except that water is used year-round. Demands increase during the summer months because of lawn and garden watering. According to information in the municipal water reservation applications (Aquoneering 1989), approximately 20 to 25 percent of the water diverted is consumed by evaporation and other processes. Much of the diverted water returns to groundwater through irrigation of parks and lawns, or through loss from leaky distribution systems. Water used for domestic purposes is sent to a wastewater treatment plant and subsequently returned to a stream or aquifer.

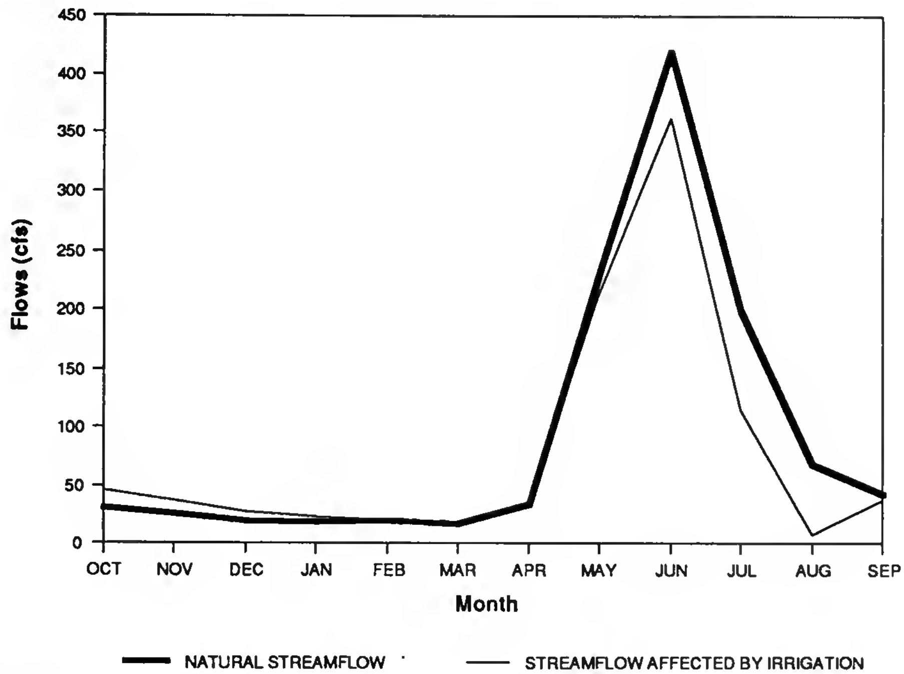
Reservoir operations also alter natural streamflow patterns. Most reservoirs are used to store high spring flows, and release water as needed during the low flow months. Maximum drawdown is usually achieved by the end of the winter, just before high spring flows begin. Most small reservoirs are designed for a single purpose, such as irrigation or stock watering, and may run dry at the end of the demand season. In contrast, large reservoirs

Figure 4-1. Missouri River basin consumptive water uses



Sources: DNRC 1990d, Missouri River Basin Commission 1981, DNRC 1985.

Figure 4-2. Natural streamflow pattern contrasted with streamflow pattern affected by irrigation[a]



a. Natural streamflows are based on measured and estimated flows for Taylor Creek in the upper Gallatin drainage near Grayling (USGS gauge #06043000) for the period of record 1928-1986. Streamflows affected by irrigation are estimated assuming 6,000 acres of new flood irrigation.

typically store water for more than one use, with numerous operational constraints.

Water storage and the associated benefits are treated as consumptive uses in Figure 4-1. This is because of the large amounts of water that are returned to the atmosphere through reservoir evaporation.

Flow Records

When available, stream gauging records provide some indication of streamflow conditions in a basin.

Percentile exceedance flows are the flow rates that have been equalled or exceeded at a given frequency over the period of record. For example, in August at USGS gauging station 06025500 on the Big Hole near Melrose, the 80th percentile flow is 340 cfs and the 20th percentile is 700 cfs for the period of record from 1937 to 1986 (USGS 1989b). That means that average flows of 340 cfs or more have been recorded in 40 of the 50 Augusts (80 percent) from 1937 to 1986. Similarly, only 10 of the 50 Augusts between these years had recorded average flows of 700 cfs or more. In assessing streamflow conditions in the basin, DNRC has generally assumed that the 80th percentile exceedance flow represents a typical low flow condition, while the 20th percentile flow represents a typical high flow condition.

To help provide a common basis for assessing flow conditions in streams throughout the basin, the USGS, in cooperation with DFWP, estimated the average monthly streamflow records at 341 sites for the 50-year period from 1937 to 1986. USGS then computed new average monthly means and 20th, 50th, 80th, and 90th percentile exceedance flows for each site. The results are published in the Water Resources Investigations Report 89-4082 (USGS 1989) and are used extensively in this draft EIS (Appendix D) and in many of the reservation applications.

HEADWATERS SUBBASIN

Flows of the Gallatin, Madison, and Jefferson rivers and their major tributaries have been measured in several locations by USGS. Average monthly, average annual, and percentile exceedance flows are shown in Table 4-1. Records at gauges near the

Table 4-1. Monthly average and percentile exceedance streamflows (cfs) for selected USGS gauges in the Headwaters Subbasin

USGS GAUGE[a]	NAME		MONTHLY FLOWS OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG.
154	Beaverhead River near Grant	Average	281	297	260	214	215	233	287	428	663	531	485	344	353
		20th %	369	418	333	260	277	303	456	698	945	746	717	463	499
		50th %	260	310	260	212	214	218	227	407	592	477	389	276	320
		80th %	138	145	142	151	147	156	158	177	303	282	255	173	186
185	Beaverhead River near Twin Bridges	Average	480	590	520	440	450	500	520	340	430	300	260	440	439
		20th %	640	710	610	510	520	590	710	560	680	400	330	570	569
		50th %	440	600	510	430	450	500	490	240	300	230	200	410	400
		80th %	260	440	410	340	380	400	360	140	160	120	100	220	278
230	Ruby River near Twin Bridges	Average	220	220	180	150	130	170	200	250	380	240	140	210	208
		20th %	260	250	200	170	150	210	290	360	550	350	190	280	272
		50th %	230	220	160	140	130	150	190	250	340	240	140	190	198
		80th %	170	190	150	120	120	120	100	120	170	120	100	150	136
255	Big Hole River near Melrose	Average	530	520	400	350	370	470	1500	3600	4400	1500	520	410	1214
		20th %	710	650	470	430	450	550	2100	5000	6400	2100	700	560	1677
		50th %	490	490	390	350	340	420	1300	3300	4200	1400	490	340	1126
		80th %	360	400	310	270	290	350	1000	2300	2700	730	340	260	776
265	Jefferson River near Twin Bridges	Average	1310	1470	1250	1060	1110	1240	2320	4010	5490	2070	839	1040	1934
		20th %	1690	1760	1450	1200	1250	1450	3010	5280	7830	3090	1140	1300	2538
		50th %	1390	1480	1260	1040	1090	1200	2080	3690	5370	1990	767	1000	1863
		80th %	902	1190	1030	893	966	1040	1640	2430	3080	913	519	705	1276
366.5	Jefferson River near Three Forks	Average	1830	1900	1440	1320	1370	1630	2700	4430	6850	2250	1010	1340	2339
		20th %	2220	2150	1770	1530	1650	1870	3270	6210	10200	3170	1400	1830	3106
		50th %	1760	1920	1420	1320	1350	1650	2710	4320	6220	1940	850	1270	2228
		80th %	1260	1520	1110	1090	1120	1370	2100	2250	3570	1010	538	890	1486
(MPC)	Madison River net inflow to Hebgen Lake	Average	863	880	799	776	758	754	930	1666	1926	993	804	826	998
		20th %	949	956	925	894	846	862	1052	2021	2533	1325	1007	960	1194
		50th %	808	786	791	758	772	754	881	1594	1814	938	758	762	951
		80th %	696	655	646	665	663	629	756	1241	1189	700	626	640	759
385	Madison River below Hebgen Lake	Average	1340	1360	970	889	824	811	915	733	1220	1020	1100	1150	1028
		20th %	1820	1880	1120	1090	951	1100	1400	1170	1840	1260	1220	1420	1356
		50th %	1380	1400	887	907	789	801	803	592	1200	1010	1060	1200	1002
		80th %	883	829	771	756	684	550	404	309	588	780	914	890	697
410	Madison River below Ennis Lake	Average	1930	1970	1520	1380	1380	1430	1570	1920	2960	1870	1560	1650	1762
		20th %	2440	2480	1680	1580	1550	1710	2080	2460	3930	2380	1800	1960	2171
		50th %	1960	2050	1520	1450	1400	1390	1490	1920	2890	1720	1560	1660	1751
		80th %	1390	1420	1270	1180	1170	1150	1010	1330	1790	1350	1370	1290	1310
425	Madison River near Three Forks	Average	1970	1860	1710	1390	1410	1450	1630	1980	3090	1870	1450	1560	1781
		20th %	2510	2250	1920	1590	1610	1790	2140	2530	4130	2450	1730	1820	2206
		50th %	1990	1920	1760	1450	1440	1410	1540	1950	3030	1720	1450	1580	1770
		80th %	1360	1410	1540	1180	1190	1190	1090	1330	1810	1310	1240	1270	1327
525	Gallatin River at Logan	Average	844	888	802	723	751	847	1130	2190	3150	1140	527	739	1144
		20th %	1060	1040	907	827	840	945	1370	2740	4440	1800	671	924	1464
		50th %	854	889	792	713	736	857	1060	2140	3230	994	483	737	1124
		80th %	601	781	725	646	647	737	901	1520	1680	478	388	563	806

Source: USGS 1989b

[a] Fourth, fifth, and sixth digits of eight digit code

rivers' confluence show average annual flows of 2,339 cfs in the Jefferson River, 1,781 cfs in the Madison River, and 1,144 cfs in the Gallatin River for a combined flow of over 3.8 million acre-feet per year (USGS 1989a). Appendix D presents the monthly and annual average and percentile exceedance flows measured or calculated by USGS at selected locations throughout the Headwaters Subbasin.

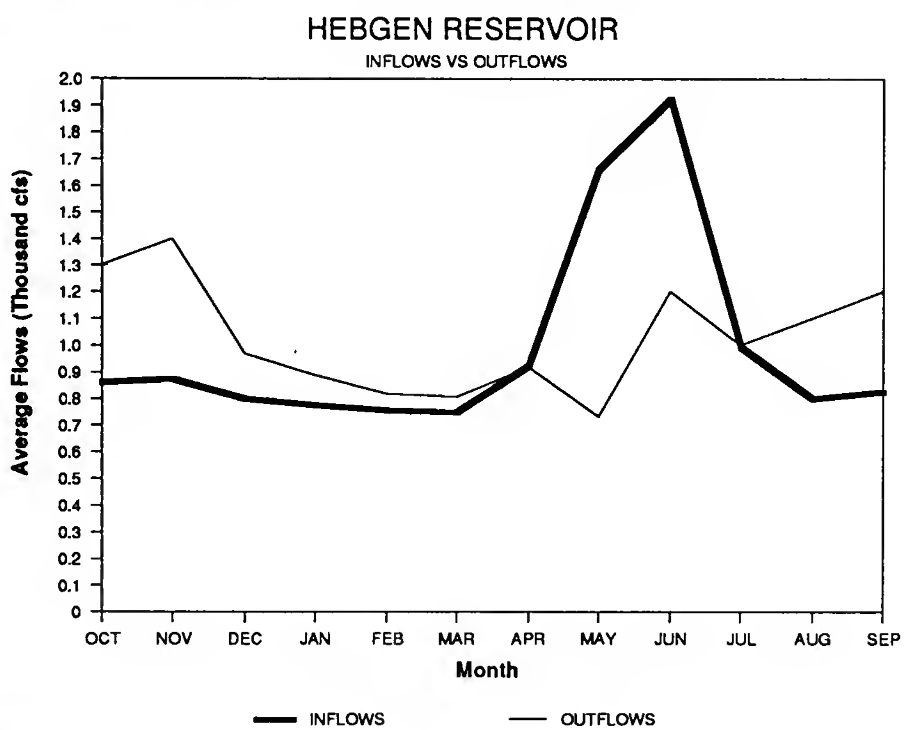
Streamflows are affected by the irrigation of approximately 655,000 acres of land under irrigation upstream from Three Forks (BUREC 1990). Because the Headwaters Subbasin is so mountainous, most of the irrigated land is in the lower valleys.

This subbasin has four major reservoirs: Hebgen Lake on the Madison River, Ruby Reservoir on the Ruby River, Lima Reservoir on the Red Rock River, and Clark Canyon Reservoir on the Beaverhead River. Ruby, Lima, and Clark Canyon reservoirs are operated to provide supplemental irrigation water, while Hebgen Lake stores water to provide more reliable flows for downstream hydropower production. These storage facilities create more uniform streamflows than would naturally occur, as illustrated in Figure 4-3. Several smaller reservoirs in the subbasin regulate streamflows locally but have a lesser effect on flows in the major tributaries.

Streamflows ranging from extremely low to zero have been observed on several stream reaches within this subbasin. The most notable examples are the Jefferson River near the mouth and for a stretch below the Waterloo Bridge south of Whitehall, and the Gallatin River near the confluence with the East Gallatin. Gauging stations on both of these streams are located just above and below the sections where extremely low flows have been observed. Portions of the lower Gallatin and Jefferson rivers near Three Forks also are known to contain natural water-losing reaches followed by water-gaining reaches. The low flows in the losing reaches are not indicated by gauging records near the mouths of these streams where flows are well above those in the losing reaches.

A partial list of streams and stream reaches that frequently exhibit low flow conditions is provided in Table 4-2. Streams with low flow conditions in this

Figure 4-3. Example of the effects of reservoir operations on streamflow patterns



Source: USGS 1989a

Table 4-2. Headwaters Subbasin— low-flow problem areas

Stream/tributary	Stream reaches where low flow occurs	Cause of low flows
Beaverhead River	East Bench Diversion Dam to Mouth	Reservoir, Irrigation
Poindexter Slough	Portions of slough	Irrigation
Spring Creek	Portions of creek	Irrigation
Rattlesnake Creek	Portions of creek	Irrigation
Big Sheep Creek	Cabin and Nicholia creeks to mouth	Irrigation
Blacktail Deer Creek	Middle Fork and West Fork to county road	Irrigation
Browns Canyon Creek	Portions of creek	Irrigation
Grasshopper Creek	Blue Creek to mouth	Irrigation
Horse Prairie Creek	Headwaters to mouth	Irrigation
Long Creek	Jones Creek to mouth	Irrigation
Medicine Lodge Creek	Bear Canyon to mouth	Irrigation
Big Hole River	Portions of river	Irrigation
Birch Creek	Mule Creek to mouth	Irrigation
Deep Creek	Sevenmile Creek to mouth	Irrigation
Jerry Creek	Portions of creek	Irrigation
Moose Creek	Portions of creek	Irrigation
Wise River	Mono & Jacobsen creeks to mouth	Irrigation
Willow Creek	Portions of creek	Irrigation
Trapper Creek	Portions of creek	Irrigation
Camp Creek	Portions of creek	Irrigation
Steel Creek	Portions of creek	Irrigation
Moose Creek	Portions of creek	Irrigation
East Gallatin River	Near confluence with Gallatin River	Irrigation
Thompson Springs Creek	Portions of creek	Irrigation
Ross Creek	Portions of creek	Natural
Reese Creek	Portions of creek	Irrigation
Dry Creek	Portions of creek	Irrigation
Baker Creek	Lane bridge to mouth	Irrigation
Bridger Creek	Headwaters to mouth	Irrigation
Hyalite Creek	Middle Creek ditch to I-90 bridge	Irrigation
South Cottonwood Creek	Jim Creek to Hart Ditch headgate	Irrigation
Sourdough Creek	Portions of creek	Irrigation
Smith Creek	Portions of creek	Irrigation
Camp Creek	Portions of creek	Irrigation
Big Bear Creek	Below forest boundary	Irrigation
Gallatin River	West Fork and East Gallatin River to mouth	Irrigation
Jefferson River	Portions of river—Waterloo Bridge to Three Forks	Irrigation, Natural
Boulder River	West Fork and South Fork to mouth	Irrigation
Little Boulder River	Moose Creek to mouth	Irrigation
East Boulder River	Portions of river	Irrigation
South Boulder River	Portions of river	Irrigation
Dry Boulder Creek	Portions of creek	Irrigation
North Willow Creek	Hollow Top Lake to mouth	Irrigation
South Willow Creek	Granite Lake to mouth	Irrigation
Whitetail Creek	Whitetail Reservoir to mouth	Irrigation
Cherry Creek	Portions of creek	Irrigation
Fish Creek	Portions of creek	Irrigation
Dry Creek	Portions of creek	Irrigation
Big Pipestone Creek	Portions of creek	Irrigation

Table 4-2 (continued)

Stream/tributary	Stream reaches where low flow occurs	Cause of low flows
Madison River	Hebgen Dam to West Fork	Reservoir
Ruby Creek	Lower portion	Irrigation
Indian Creek	Lower portion	Irrigation
Blaine Springs Creek	Ennis Fish Hatchery to mouth	Irrigation
Jack Creek	Lone Creek to mouth	Irrigation
Hot Springs Creek	North and Middle Forks to mouth	Irrigation
Cherry Creek	Lower 4.5 miles	Irrigation
North Meadow Creek	Portions of creek	Irrigation
Red Canyon Creek	Portions of creek	Natural
Red Rock River	Lima Dam to Clark Canyon Reservoir	Reservoir, Irrigation
Big Sheep Creek	Portions of creek	Irrigation
Odell Creek	Portions of creek	Irrigation
Sage Creek	Portions of creek	Irrigation
Long Creek	Portions of creek	Irrigation
Little Sheep Creek	Portions of creek	Irrigation
Ruby River	Ruby Reservoir to mouth	Irrigation
Wisconsin Creek	Portions of creek	Irrigation
Mill Creek	Portions of creek	Irrigation
Alder Gulch	Portions of creek	Irrigation
Sweetwater Creek	Portions of creek	Irrigation
Indian Creek	Portions of creek	Irrigation

and other subbasins were identified by hydrologists and water rights analysts at DNRC, and DFWP fisheries biologists.

UPPER MISSOURI SUBBASIN

The USGS measures Missouri River flows at Toston, near Ulm, and near Great Falls (Table 4-3). Additional streamflow measurements are available from BUREC at Canyon Ferry Dam and from MPC at Hauser and Holter dams. USGS also measures flows on the Dearborn, Smith, and Sun rivers, Belt Creek, and Muddy Creek (Table 4-3). These gauging records show average annual flows in the Missouri River ranging from 5,193 cfs at Toston above Canyon Ferry Reservoir to 7,473 cfs near Great Falls. Average annual tributary contributions include 203 cfs from the Dearborn River, 342 cfs from the Smith River, 208 cfs from Belt Creek, and 734 cfs from the Sun River (USGS 1989a). Although USGS measures flows on all of the major streams in this subbasin, most of the smaller waterways remain ungauged. Appendix D presents the monthly and annual average and percentile exceedance flows measured or computed by USGS at selected locations in the basin.

The natural monthly streamflow patterns in this subbasin are similar to those in the Headwaters Subbasin, but there tends to be less streamflow per unit area due to lower elevations and less snowpack accumulation. In general, this area also is drier year-round than the headwaters area.

The irrigation of 282,000 acres alters streamflow patterns in this subbasin (BUREC 1990). Although much less land is irrigated than in the Headwaters Subbasin, irrigation does affect flows in many of the smaller streams that feed the main stem and larger tributaries.

The operation of Canyon Ferry Dam, a multipurpose facility used to store water for irrigation, hydropower, flood control, and recreation, has the biggest influence on the Missouri River's monthly flow. Operations are aimed at storing high spring flows to fill the reservoir by the end of June and then releasing water gradually over the summer, fall, and winter to reach maximum drawdown by the end of

Table 4-3. Monthly average and percentile exceedance streamflows (cfs) for selected USGS gauges in the Upper Missouri Subbasin

USGS GAUGE[a]	NAME		MONTHLY FLOWS OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG.
545	Missouri River	Average	4470	4770	3860	3430	3770	4070	5670	8780	12300	5080	2620	3500	5193
	at Toston	20th %	5380	5640	4250	3860	4230	4790	7160	11600	17700	7040	3340	4600	6633
		50th %	4410	4670	3830	3400	3750	3940	5570	8720	11900	4580	2380	3410	5047
		80th %	3480	3980	3300	2960	3390	3520	3990	5240	7140	2670	1830	2560	3672
BUREC	Missouri River	Average	4431	4701	3757	3393	3777	4338	5673	8648	11722	5042	2657	3436	5131
	net inflow to	20th %	5397	5540	4134	3891	4355	5177	7242	11836	17139	7636	3354	4289	6666
	Canyon Ferry	50th %	4384	4683	3750	3395	3878	4170	5113	7969	11359	4549	2374	3437	4922
	Reservoir	80th %	3273	3780	3204	2773	3030	3484	4008	5034	6295	2433	1864	2470	3471
BUREC	Missouri River	Average	4166	4525	4458	4257	4315	4711	5558	7078	9243	5517	3662	3601	5091
	outflow from	20th %	5048	5340	5349	5514	5514	5920	7383	9754	12862	7621	4775	4378	6622
	Canyon Ferry	50th %	4048	4335	4446	4289	4270	4465	5218	6469	8717	5042	3568	3697	4880
	Reservoir	80th %	3111	3389	3464	2989	3289	3481	3806	3798	4821	2960	2297	2498	3325
MPC	Missouri River	Average	4162	4496	4486	4312	4312	4735	5535	7021	9221	5538	3690	3644	5096
	at Hauser Dam	20th %	5057	5348	5334	5515	5512	5887	7367	9658	12651	7612	4927	4383	6604
		50th %	4034	4281	4498	4356	4209	4600	5155	6355	8643	5027	3618	3616	4866
		80th %	3072	3518	3600	3090	3065	3532	3448	3669	4764	2931	2355	2588	3303
665	Missouri River	Average	4470	4820	4980	4860	4760	5100	5670	7190	9970	5880	4040	4000	5478
	below Holter Dam	20th %	5380	5680	5720	6000	6100	6290	7480	10000	14100	8000	5260	5070	7090
		50th %	4400	4700	4880	4890	4630	4960	5500	6990	9210	4960	3940	3910	5248
		80th %	3340	3940	4010	3820	3780	4050	3370	3750	5210	3660	2880	2900	3726
735	Dearborn River	Average	72	72	67	56	61	84	200	680	810	210	70	56	203
	near Craig	20th %	91	92	83	67	71	100	350	1000	1100	340	100	75	289
		50th %	70	68	62	53	57	77	180	670	710	180	68	52	187
		80th %	48	51	47	41	46	54	91	360	300	89	33	32	99
775	Smith River	Average	165	154	119	100	145	172	417	994	1080	452	159	150	342
	near Eden	20th %	190	201	152	140	192	238	564	1520	1440	739	225	194	483
		50th %	135	158	106	93	132	163	357	860	924	365	141	122	296
		80th %	114	101	66	61	88	107	213	464	529	185	83	85	175
782	Missouri River	Average	4830	5250	5350	5260	5280	5700	6830	9780	12800	7260	4310	4260	6409
	near Ulm	20th %	6020	6240	6130	6380	6530	6830	8780	12800	17600	10000	5850	5300	8205
		50th %	4730	5040	5290	5320	5140	5660	6680	9200	11700	6570	4120	4220	6139
		80th %	3650	4210	4510	4210	4350	4490	4180	6270	7190	4020	2740	3070	4408
885	Muddy Creek	Average	109	63	46	35	38	56	43	144	251	281	310	192	131
	at Vaughn	20th %	132	72	55	46	51	67	50	177	313	357	381	234	161
		50th %	109	65	44	35	35	39	36	131	231	280	324	191	127
		80th %	84	51	35	25	27	32	30	104	175	197	239	158	96
890	Sun River	Average	379	330	297	249	260	334	471	1660	2940	859	582	442	734
	near Vaughn[b]	20th %	467	376	341	319	335	472	712	2419	4393	1174	758	568	1028
		50th %	367	327	284	238	244	267	360	1214	2072	679	576	423	588
		80th %	260	255	225	185	180	174	194	573	1091	361	398	312	351
903	Missouri River	Average	5810	5930	5820	5730	5920	6500	7720	11700	15600	8500	5360	5090	7473
	near Great Falls	20th %	6840	7270	6770	7140	7480	8070	10100	15700	21300	11800	7200	6320	9666
		50th %	5490	5600	5800	5420	5850	6140	7600	10900	15100	7840	5090	4890	7143
		80th %	4950	4920	4770	4620	4660	5050	5010	7630	8530	4880	3750	3830	5217
906.1	Belt Creek	Average	46	34	24	17	19	27	140	770	1100	220	59	42	208
	near Portage	20th %	61	48	34	27	28	37	270	1200	1700	330	91	60	324
		50th %	37	31	22	17	17	24	100	540	710	150	54	35	144
		80th %	21	18	12	9	11	13	46	320	390	85	27	18	81

Source: USGS 1989b

[a] Fourth, fifth, and sixth digits of eight digit code

[b] Source: USGS 1981

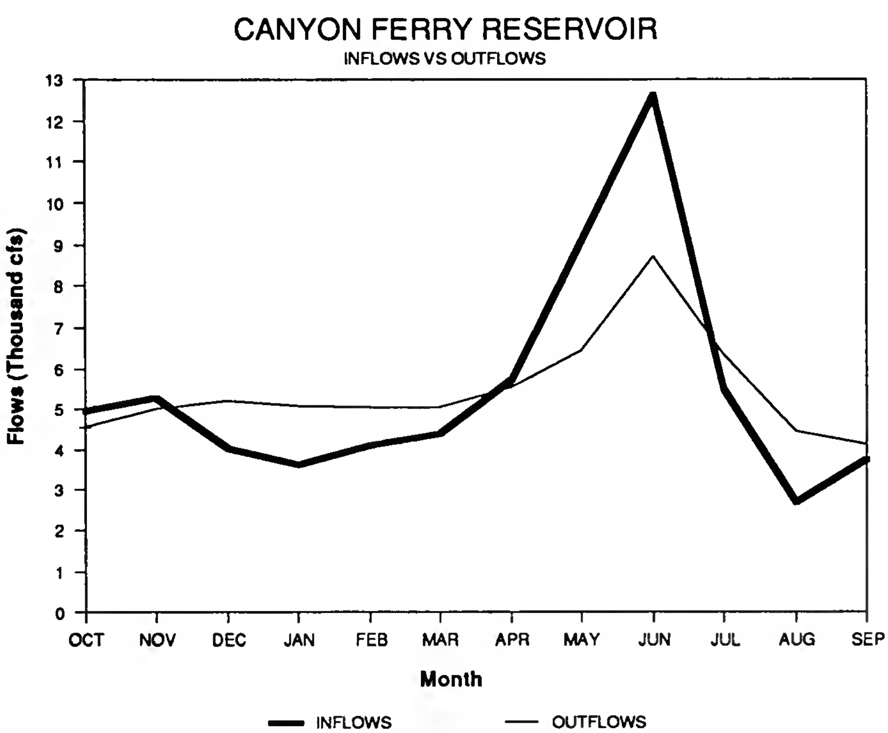
February. BUREC plans releases in cooperation with MPC and DFWP to maximize benefits in hydropower production and recreation. Figure 4-4 presents average monthly inflow and outflow for Canyon Ferry Lake to illustrate the dam's regulating effects on main-stem river flows.

MPC's Hauser and Holter dams, located just downstream from Canyon Ferry, also alter main-stem streamflows, but to a much lesser degree than Canyon Ferry. Both dams are generally operated as run-of-the-river facilities; they have little storage, and water runs out as fast as it flows in. However, Holter Reservoir has enough storage to significantly alter streamflows on a daily to weekly basis. Neither facility is large enough to alter monthly streamflow patterns to any significant degree. MPC operates five run-of-the-river dams near Great Falls—Rainbow, Black Eagle, Ryan, Cochran, and Morony—for hydropower generation. As with the Hauser and Holter facilities, these dams can be used to alter flows on a daily basis, but not on a monthly scale.

Sun River flows are altered by a combination of irrigation and reservoir operations. Gibson, Pishkun, and Willow Creek reservoirs store water for irrigation, including the large Greenfields Bench project. A few miles below Gibson Dam, the Pishkun Canal diverts a large portion of the Sun River into Pishkun Reservoir. From there, water is distributed to approximately 11,000 acres through the Sun River Slope Canal, Spring Valley Canal, Greenfields Main Canal, and, farther downstream, the Sun River Ditch and Fort Shaw Canal supply approximately 110,000 acres of irrigated land.

Irrigation causes most of the seasonal low-flow conditions observed in this subbasin (Table 4-4). Irrigation use and geological conditions in Dry Creek, Confederate Gulch, and Avalanche Creek on the east side of the Missouri River and Canyon Ferry Reservoir cause most of the severe low-flow conditions below the national forest boundary. Low-flow conditions are common in the Sun River below the diversion dam that feeds Pishkun Canal. This condition persists throughout the summer as long as irrigation diversions are occurring. Much of the diverted water is returned to the Sun River via Muddy Creek, which picks up most of the return flows from the Greenfields

Figure 4-4. Effects of Canyon Ferry Reservoir on Missouri River flows



Source: USGS 1989a

Table 4-4. **Upper Missouri Subbasin—low flow problem areas**

Stream-Tributary	Stream Reaches	Cause
Missouri River		
(Three Forks to Canyon Ferry)		
Avalanche Creek	Cooney Gulch to Canyon Ferry Reservoir	Irrigation, Natural
Beaver Creek	Headwaters to Canyon Ferry Reservoir	Irrigation
Confederate Gulch	Debauch Gulch to mouth	Irrigation, Natural
Crow Creek	Tizer & Wilson Creeks to Williams Ditch intake	Irrigation
Deep Creek	Castle Fork to Missouri River	Irrigation
Dry Creek	Headwaters to Broadwater Missouri Canal	Irrigation, Natural
Duck Creek	Headwaters to Canyon Ferry Reservoir	Irrigation
Sixteenmile Creek	Billy Creek to mouth	Irrigation
Smith River	Portions of creek	Irrigation
Butte Creek	Portions of creek	Irrigation
Camas Creek	Portions of creek	Irrigation
Eagle Creek	Portions of creek	Irrigation
Hound Creek	Portions of creek	Irrigation
Newlan Creek	Portions of creek	Irrigation
N. Fork Smith River	Portions of creek	Irrigation
Sheep Creek	Portions of creek	Irrigation
Spring Creek	Portions of creek	Irrigation
Thomas Creek	Portions of creek	Irrigation
Missouri River		
(Canyon Ferry to Holter Dam)		
Spokane Creek	Helena Valley Canal to mouth	Natural, Irrigation
Trout Creek	Vigilante Campground to mouth	Irrigation
Prickly Pear Creek	East Helena Highway Bridge to Lake Helena	Irrigation
Tenmile Creek	Portions of creek	Irrigation
Silver Creek	Helena Valley Canal to mouth	Irrigation
Canyon Creek	Portions of creek	Irrigation
Little Prickly Pear	Headwaters to 5.5 miles downstream	Irrigation
Little Prickly Pear	Clark Creek to mouth	Irrigation
Wegner Creek	Portions of creek	Natural
Stickney Creek	North and South Forks to mouth	Natural
Sevenmile Creek	Headwaters to Tenmile Creek	Irrigation
Dearborn River	Portions of creek	Irrigation
South Fork Dearborn	Portions of creek	Irrigation
Sun River	Diversion dam to mouth	Irrigation
Big Muddy Creek	Portions of creek	Irrigation
Willow Creek	Portions of creek	Irrigation
Elk Creek	Portions of creek	Irrigation
Mill Coulee	Portions of creek	Irrigation
Ford Creek	Portions of creek	Irrigation
Smith Creek	Portions of creek	Irrigation
Belt Creek	Big Otter Creek to Missouri	Natural
Little Belt Creek	Portions of creek	Natural
Big Otter Creek	Portions of creek	Natural

Bench irrigation project. Flows in the middle and lower sections of the Smith River also can be seriously reduced in the late summer due to irrigation diversions. Natural low flow conditions occur in a losing reach of Belt Creek for about 13 miles below the confluence of Otter Creek. This reach has only intermittent flows during dry years (DFWP 1989a).

MARIAS/TETON SUBBASIN

USGS measures Marias River flows at the mouth near Loma and several locations upstream (Table 4-5). Additional data are collected by BUREC at Tiber Dam. Teton River flows are measured at upstream locations, but not near the mouth. These records show average annual flows of 877 cfs in the Marias near the mouth and 148 cfs in the middle section of the Teton River at the gauge near Dutton (USGS 1989a). The major headwater tributaries of the Marias and Teton also have been measured, but most other small streams in the subbasin are ungauged. Appendix D presents the monthly, average annual, and percentile exceedance flows for several gauging stations as measured or computed by the USGS.

The headwaters of this subbasin originate in the mountains, and the natural streamflow pattern is snowmelt-dominated. Many of the natural streamflow patterns, however, are altered by the numerous irrigation storage and diversion facilities in the upper portion of the subbasin. These facilities provide water for approximately 218,000 acres of irrigated land (BUREC 1990), most of which is concentrated around the tributaries of the Marias and Teton rivers.

Though many small irrigation dams are located on the headwater tributaries, BUREC's Tiber Reservoir on the Marias River has the greatest impact on monthly streamflow patterns in the subbasin. Tiber Reservoir, originally designed to supply water to the proposed Lower Marias Irrigation Unit and potentially to support new hydropower development, is currently used for flood control, recreation, and streamflow maintenance, with a small portion of the water used for irrigation and municipal supplies. Operation of this facility is guided by the intention to fill the reservoir by the end of June and draw the reservoir down by the end of February (BUREC

Table 4-5. Monthly average and percentile exceedance streamflows (cfs) for selected USGS gauges in the Marias/Teton Subbasin

USGS			MONTHLY FLOWS												
GAUGE[a]	NAME		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG.
0995	Marias River net inflows to Tiber Reservoir	Average	379	372	284	244	345	666	1113	2626	3155	1025	349	313	906
		20th %	497	448	367	319	460	962	1363	3487	4062	1457	472	474	1197
		50th %	301	320	239	207	265	450	1050	2435	2403	795	261	235	747
		80th %	183	202	154	148	162	279	517	1813	1441	449	165	157	473
1015	Marias River outflows from Tiber Reservoir	Average	586	524	340	280	351	595	1041	1910	2442	1246	724	636	890
		20th %	964	843	472	379	576	908	1425	2605	3495	1867	1012	968	1293
		50th %	429	378	282	233	255	422	880	1812	1715	927	538	445	693
		80th %	253	198	178	144	149	269	391	941	937	542	193	217	368
1020	Marias River near Loma	Average	862	637	393	331	422	476	885	1390	1850	1330	1070	875	877
		20th %	1070	841	654	499	632	751	1280	1700	2560	1990	1550	1080	1217
		50th %	814	625	373	303	417	394	829	1360	1460	1340	978	719	801
		80th %	537	367	181	161	216	222	493	1090	745	680	537	422	471
1080	Teton River near Dutton	Average	75	76	68	55	86	172	180	326	417	170	80	69	148
		20th %	106	97	94	66	95	196	252	435	556	266	116	90	197
		50th %	63	70	58	55	67	115	149	337	315	144	67	59	125
		80th %	40	44	39	42	47	72	103	113	137	64	45	39	65

Source: USGS 1989b

[a] Third, fourth, fifth, and sixth digits of eight digit code

1986). The average monthly inflow and outflow hydrographs for Tiber are presented in Figure 4-5.

Low-flow conditions in the Marias River drainage are limited, with only occasional problems in some small tributary streams (Table 4-6). A similar situation exists in the tributaries of the Teton River. The Teton itself, however, is occasionally low in stretches above Choteau and near the mouth. The reach near the mouth is ungauged, and the severity of the low-flow condition there is difficult to quantify.

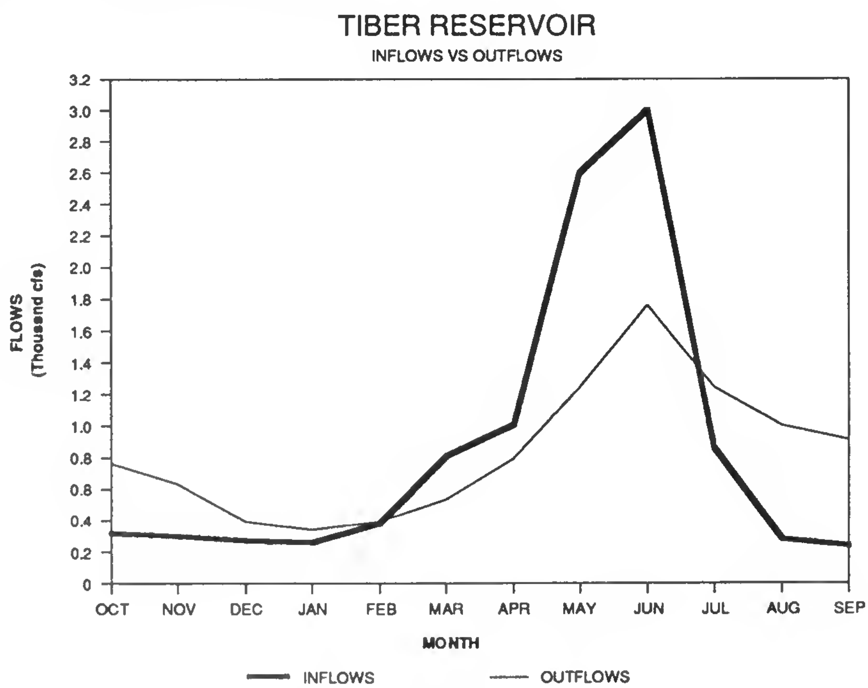
MIDDLE MISSOURI SUBBASIN

The Middle Missouri Subbasin includes the land draining into the Missouri main stem from the mouth of Belt Creek downstream to Fort Peck Dam. This drainage area includes the Judith and Musselshell river basins. Unlike the other three subbasins, streams in this region do not originate in the Rocky Mountains. Instead, water drains from lower and more isolated ranges including the Little Belt, Castle, Crazy, Big Snowy, Judith, Bear Paw, and Little Rocky mountains and from the eastern plains.

The Missouri River and its tributaries are measured by USGS gauges at several locations. Average and percentile exceedance streamflows are presented in Table 4-7. These records show average annual flow of 7,688 cfs at Fort Benton and 9,325 cfs passing Fort Peck Dam (USGS 1989a). On the Judith River, USGS measures flows in the headwater tributaries and near the mouth. The gauge near the mouth near Winifred shows an average annual flow of 480 cfs (USGS 1989a). The Musselshell River has been measured at Harlowton, near Roundup, and near Mosby. Average annual flows at these sites range from 156 cfs at Harlowton to 210 cfs near Roundup, then up to 310 cfs near Mosby (USGS 1989a). Big Dry Creek, which enters the Big Dry arm of Fort Peck Reservoir, contributes an average 57 cfs to the reservoir (USGS 1989a). Appendix D presents a summary of the monthly mean and percentile exceedance flows for selected streams throughout the subbasin.

Although streams in this subbasin originate in lower mountain ranges, most natural streamflows still exhibit snowmelt-dominated characteristics. This basin also contains numerous spring-fed streams that tend to flow at relatively constant rates year-round. Streamflow patterns have been altered by irrigating approximately 89,000 acres.

Figure 4-5. Effects of Tiber Reservoir on Marias River flows



a. Based on recorded and estimated streamflows by BUREC and USGS (1928-1986 period of record)

Table 4-6. Marias/Teton Subbasin—low-flow problem areas

Stream/tributary	Stream reaches where low flows occur	Cause of low flows
Marias River	Portions of river	Irrigation
Cut Bank Creek	Portions of creek	Irrigation
Dupuyer Creek	Portions of creek	Irrigation
North Fork Dupuyer Creek	To Dupuyer Creek	Irrigation
South Fork Dupuyer Creek	To Dupuyer Creek	Irrigation
North Fork Willow Creek	To Willow Creek	Irrigation
South Fork Willow Creek	To Willow Creek	Irrigation
Birch Creek	Portions of creek below diversions	Irrigation
Teton River	Below Priest Butte Lake	Irrigation
Deep Creek	Portions of creek	Irrigation
North Fork Deep Creek	To Deep Creek	Irrigation
South Fork Deep Creek	To Deep Creek	Irrigation
Willow Creek	To Deep Creek	Irrigation
McDonald Creek	To Teton River	Irrigation
Spring Creek	Portions of creek	Irrigation

Table 4-7. Monthly average and percentile exceedance streamflows (cfs) for selected USGS gauges in the Middle Missouri Subbasin

USGS GAUGE	NAME		MONTHLY FLOWS OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG.
0908	Missouri River	Average	5630	5950	5880	5820	6050	6610	7930	12500	16600	8770	5370	5150	7688
	at Fort Benton	20th %	6920	7160	6990	7210	7630	7990	10100	17700	23100	12300	6920	6330	10029
		50th %	5350	5560	5790	5480	5960	6340	7690	11500	15600	7920	5150	4930	7273
		80th %	4330	4950	4810	4650	4700	5280	5140	8000	9020	5210	3750	3720	5297
1095	Missouri River	Average	6310	6550	6380	6270	6640	7570	9140	14400	19700	10300	6210	5880	8779
	at Virgelle 20th %	7650	7560	7370	7710	8370	9120	12100	18800	26200	14300	8130	7050	11197	
		50th %	6140	6390	6450	5950	6650	7170	8510	13400	18000	9990	5800	5430	8323
		80th %	4890	5360	5180	4870	5180	5660	6210	9920	11700	5620	4310	4250	6096
1135	Judith River Average	407	417	424	434	483	537	519	538	548	548	469	440	480	
	near Winifred	20th %	554	581	594	603	641	707	725	722	724	674	669	638	653
		50th %	419	446	473	485	527	587	495	533	553	555	480	473	502
		80th %	243	243	246	243	251	306	294	358	303	316	247	243	274
1152	Missouri River	Average	6790	7060	6850	6690	7310	8930	10100	15500	21700	11500	6780	6360	9631
	near Landusky	20th %	8080	7980	7880	8290	9330	10700	13900	21200	28800	15400	8730	7690	12332
		50th %	6700	6770	6900	6600	7240	8380	9170	14200	19500	11400	6550	5930	9112
		80th %	5340	5900	5590	5180	5460	6580	7000	10200	12800	6210	4700	4590	6629
1305	Musselshell River	Average	82	87	82	86	219	545	349	633	1040	350	117	128	310
	near Mosby	20th %	119	139	132	121	280	634	543	955	1750	496	224	178	464
		50th %	69	74	67	70	120	272	182	360	589	136	87	73	175
		80th %	15	36	31	21	48	115	88	100	153	51	20	20	58
1310	Big Dry Creek	Average	5	3	3	3	62	301	100	35	77	57	16	19	57
	near Van Norman	20th %	8	4	2	2	98	642	50	34	136	47	14	9	87
		50th %	2	2	1	0	3	73	10	8	28	9	4	1	12
		80th %	0	1	0	0	0	7	4	3	3	1	0	0	2
1320	Missouri River	Average	11500	8830	8320	8710	8660	7420	7300	7900	8160	10200	12700	12200	9325
	below Fort	20th %	15300	13100	11300	12600	13800	11100	10300	11900	12600	13200	18100	18300	12484
	Peck Dam	50th %	10300	9010	9320	9860	8240	7620	7240	6960	7900	10100	12100	11400	9171
		80th %	5310	4870	5450	4670	2820	3480	3830	3890	3690	5620	7570	6360	4797

Source: USGS 1989b

[a]. Third, fourth, fifth, and sixth digits of eight digit code

Irrigation is especially prevalent in the Musselshell River basin where streamflows are almost completely regulated by irrigation and irrigation storage facilities. Flows in the Musselshell River are regulated by Bair, Martinsdale, and Deadmans Basin reservoirs. All of these facilities are designed to provide water for downstream irrigation diversions. Farther downstream on Flatwillow Creek, local streamflows are regulated by Petrolia Reservoir. Many smaller irrigation and stockwater reservoirs alter streamflows locally, but have little effect on flows in the larger streams.

The largest storage facility in the subbasin, and in the state, is the U.S. Army Corps of Engineers' Fort Peck Reservoir. This facility is operated in conjunction with the Corps' five other main-stem Missouri facilities in downstream states for flood control, navigation, irrigation, municipal water supplies, and recreation. Operations are very similar to the other large reservoirs in the basin, storing spring flows to fill the reservoir by the end of June, then releasing water throughout the summer, fall, and winter to reach maximum drawdown by the end of February.

One of the reservation applicants proposed to pump groundwater from abandoned underground coal mines near Roundup to augment Musselshell River flows during the irrigation season. These mines contain large amounts of water. At least one of the mines, the Jeffrey, is in contact with the Musselshell River alluvial aquifer. The mines are also in contact with Fort Union formation aquifers close to the Roundup coal bed.

Table 4-8 identifies streams with low-flow problems in this subbasin. DFWP indicated in its reservation application that an upper reach of the Judith River has severe low-flow conditions for several miles due to locally intensive irrigation (DFWP 1989a). Low- flow conditions also are found in the Musselshell River downstream from Deadmans Basin diversion to Careless Creek and between Melstone and Mosby. Low-flow conditions in the Musselshell River are caused largely by canal diversions for irrigation. Before the reservoirs were constructed, severe low-flow conditions were so common that locals often used the streambed as a roadway. Most of the tributary streams in this area, including Big and Little Dry creeks, are naturally intermittent and flow primarily during periods of high runoff.

LEGAL WATER AVAILABILITY IN THE MISSOURI BASIN

For the Board to grant a water reservation, it must find that the reservation will not adversely affect senior water rights. Although all applicants claim that water is physically available for their reservations, this water may already be appropriated under existing water claims, permits, or federal

Table 4-8. Middle Missouri Subbasin—low-flow problem areas

Stream/tributary	Stream reaches where low flows occur	Cause of low flows
Judith River	South Fork and North Fork to Big Springs Creek	Irrigation
South Fork Judith River	Portions of creek	Natural
Louse Creek	Portions of creek	Irrigation
McCarthy Creek	Portions of creek	Irrigation
Cottonwood Creek	Portions of creek	Natural
Musselshell River	Deadmans Basin diversion to Musselshell diversion	Irrigation
South Fork Musselshell River	Headwaters to North Fork and below diversion	Irrigation
Cottonwood Creek	Loco Creek to mouth	Irrigation
Checkerboard Creek	East and West forks to mouth	Irrigation
Spring Creek	Portions of creek	Natural
Big Elk Creek	Lebo Fork origin to mouth	Irrigation
American Fork Creek	South Fork to mouth	Natural
Careless Creek	Headwaters to Roberts Creek	Irrigation
Swimming Woman Creek	Headwaters to 8 miles above mouth	Irrigation
Collar Gulch	Portions of creek	Irrigation
Flagstaff Creek	Portions of creek	Irrigation

reserved water rights that have a priority date before July 1, 1985.

Status of Water Right Claims

Claims for existing state water rights in the Missouri River basin are summarized by use and subbasin in Appendix A. Montana water law defines an existing claim as a water right that was in existence before July 1, 1973. Claims for each of Montana's 85 subbasins will eventually be adjudicated. Of these, 28 subbasins lie within the Missouri River basin above Fort Peck Dam. Map 4-1 indicates the status of the adjudication in those 28 basins. The courts have not issued a final decision or "Final decree" for any of the subbasins on Map 4-1.

Preliminary decrees have been issued in subbasins 41N and 40D. After the decree was issued in subbasin 40D, the possible existence of federal reserved water rights was discovered. If federal reserved rights are found in 40D, then the decree may have to be treated as a temporary preliminary decree. A temporary preliminary decree is different from a preliminary decree in that the latter does not involve federally reserved water rights.

Temporary preliminary decrees have been issued in 11 other subbasins. DNRC is examining claims in three more subbasins. The remaining 12 subbasins have had little or no activity related to the adjudication, and most of these basins will not be examined by DNRC or acted upon by the Water Court before the reservation process is completed.

Status of Water Right Permits

Provisional water use permits are water rights issued by DNRC since July 1, 1973, as summarized in Appendix A. In this draft EIS, provisional water use permits have been sorted into two categories—before and after July 1, 1985—the priority date for reservations in the Missouri River basin.

Since 1973, 674 provisional water use permits have been issued in the Missouri River basin above Morony Dam at Great Falls. Of these, 231 are for water above Canyon Ferry Dam.

MPC and BUREC began objecting to DNRC's issuance of new water use permits above Morony Dam in 1978, claiming that any additional use would adversely affect their existing water rights. This matter came to the forefront when DNRC issued an order in 1984 granting a new water use permit to Don Brown. The DNRC decision was appealed to the First Judicial District Court and reversed in June 1987 (Case No. 50612, First Judicial District, Lewis and Clark County). The District Court found that DNRC did not have the authority to reduce BUREC's claimed right; only the water court could make that determination. The court order resulted in the voidance of Don Brown's permit as well as all permits issued after Don Brown's. Because of this and in order that new water uses would not be completely stopped in the upper Missouri River basin, DNRC, MPC, and BUREC agreed to the following stipulations in November 1987:

1. BUREC and MPC would petition the Water Court for a determination of their water rights in the upper Missouri River Basin, and DNRC would support such an effort. (It should be noted that the Water Court in May 1988 turned down a request for a special basin-wide determination of BUREC and MPC water rights.)

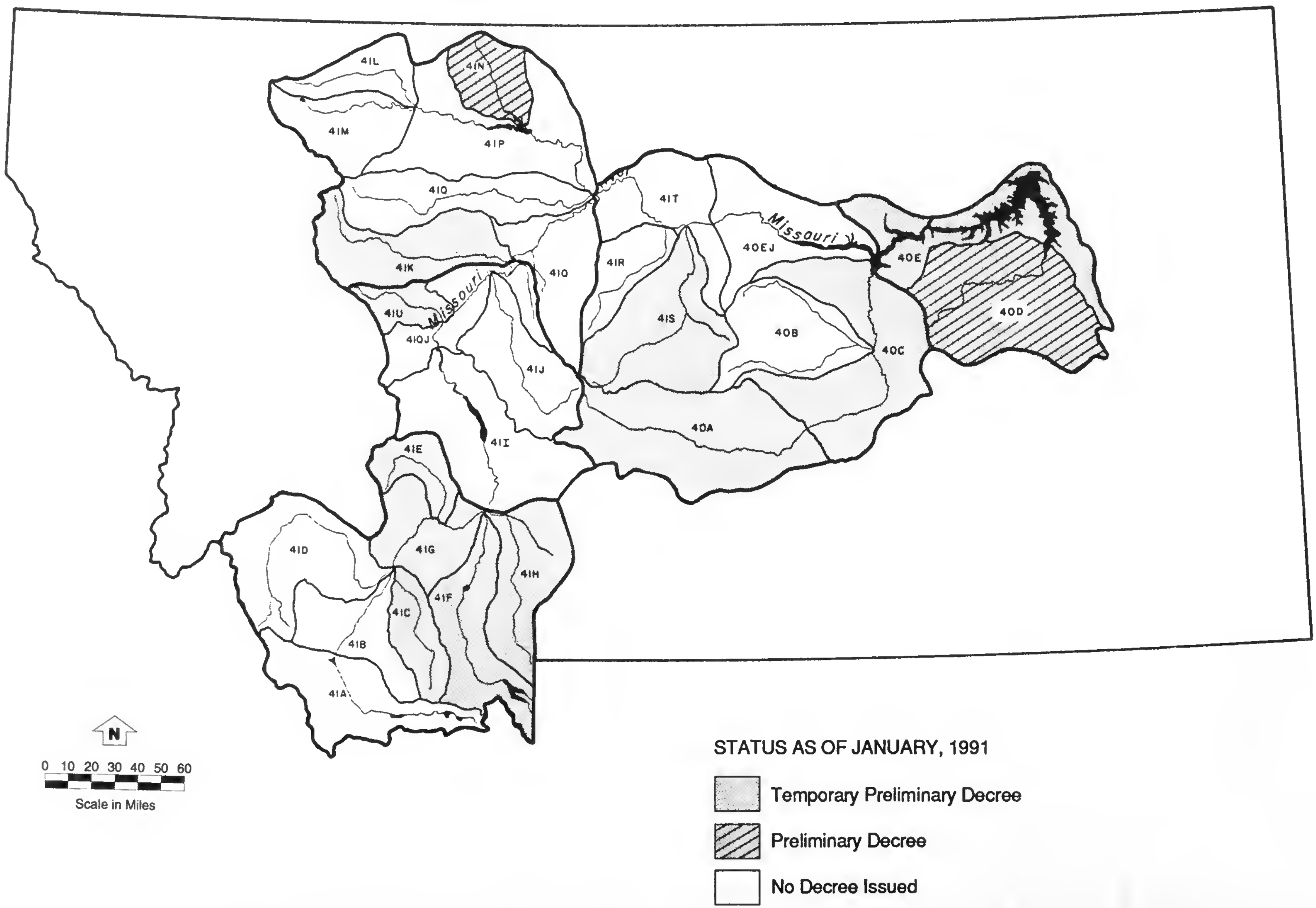
2. DNRC would not appeal the district court decision to the Montana Supreme Court.

3. BUREC and MPC would continue to object to new water use permit applications in the upper Missouri River Basin, but would not insist on hearings if applicants acquire water service contracts from BUREC to use water stored in Canyon Ferry Reservoir.

4. If applicants refuse to obtain a contract and insist on hearings before DNRC, DNRC would certify the case to the Water Court pursuant to Montana water law for a determination of BUREC's and MPC's underlying water rights.

Since 1987, DNRC has issued 70 provisional permits in the basin with 45 of these for water above Canyon Ferry Reservoir. Ten of the 70 permits, which are intended for irrigation use, resulted in the purchase of temporary water service contracts from BUREC after objections were received from MPC. Sixty permits were for nonconsumptive uses such as mining, power generation, and fisheries and wildlife purposes and were not objected to by MPC. The 75 remaining applications for provisional water use permits are pending because objections have been filed by MPC and the applicants have chosen not to acquire water-service contracts.

Map 4-1. Status of water rights adjudication in the Missouri basin



In April 1989, DHES informed BUREC that the issuance of a water service contract for a consumptive use would violate existing water quality standards for arsenic. Because of this, BUREC plans to prepare an EIS on marketing water for consumptive uses from Canyon Ferry Reservoir over the next few years. Until the EIS is completed, BUREC is informing each potential applicant that it must pay the cost(s) for preparing an environmental review to determine any effect the project may have on arsenic concentrations in the Missouri River. BUREC estimated that the cost for each assessment would probably exceed $10,000. Since April 1989, no consumptive use permit or water service contract has been issued.

MPC'S WATER RIGHT CLAIMS

Fifteen to 20 percent of MPC's total electrical power generation capacity is produced at its seven Missouri River main-stem reservoirs—Hauser, Holter, Black Eagle, Rainbow, Cochrane, Ryan, and Morony. MPC has claimed water rights for each of these facilities based on flows needed to operate its hydropower turbines. These claims are summarized in Table 4-9.

If these water rights are adjudicated as claimed, water available for future consumptive uses would be severely limited. Using the Missouri River water availability model explained in Appendix C, MPC's claimed water rights for operating its turbines were subtracted from the baseline flow condition (a 1986 level of development with Canyon Ferry in place for the period of record is assumed). Results for MPC's seven main stem facilities are in Table 4-10. Water would be available for future consumptive uses upstream of Holter Dam in fewer than 5 years in 10 and only during March, April, May, June, and July. Cochrane Dam with its claim of 10,000 cfs could

Table 4-9. Summary of major MPC claims in the Missouri basin

PLACE OF USE	SOURCE	TYPE OF USE	AMOUNT (cfs)	AMOUNT (af)	PRIORITY DATE
Hebgen Dam	Madison River	Storage	2,000		4/30/1906
Hebgen Dam	Madison River	Storage	6,000		4/30/1906
Hebgen Dam	Madison River	Storage	186,699		6/1/1914
Madison Dam	Madison River	Power generation	1,650	1,127,120	8/24/1895
Madison Dam	Madison River	Storage	19,720		8/24/1895
Holter Dam	Missouri River	Power generation	7,100	5,183,000	4/30/1918
Holter Dam	Missouri River	Storage	41,300		4/30/1918
Canyon Ferry Dam	Missouri River	Storage	23,980		10/31/1898
Hauser Dam	Missouri River	Power generation	4,740	3,493,000	6/23/1905
Hauser Dam	Missouri River	Storage	3,380		6/23/1905
Hauser Dam	Missouri River	Storage	8,120		8/25/1906
Hauser Dam	Missouri River	Storage	3,000		8/27/1906
Hauser Dam	Missouri River	Storage	19,100		8/28/1907
Black Eagle Dam	Missouri River	Power generation	3,300	2,409,000	6/1/1892
Black Eagle Dam	Missouri River	Power generation	900	657,000	12/31/1893
Black Eagle Dam	Missouri River	Power generation	280	204,400	12/31/1912
Black Eagle Dam	Missouri River	Power generation	560	408,800	8/31/1927
Black Eagle Dam	Missouri River	Storage	862		8/31/1927
Rainbow Dam	Missouri River	Power generation	3,500	2,555,000	9/16/1908
Rainbow Dam	Missouri River	Storage	532		9/16/1908
Rainbow Dam	Missouri River	Power generation	1,640	1,197,200	7/1/1917
Rainbow Dam	Missouri River	Power generation	480	292,000	3/26/1958
Cochrane Dam	Missouri River	Power generation	10,000	7,300,000	6/16/1955
Cochrane Dam	Missouri River	Storage	2,961		6/16/1955
Ryan Dam	Missouri River	Power generation	5,900	4,307,000	8/31/1915
Ryan Dam	Missouri River	Storage	1,407		8/31/1915
Morony Dam	Missouri River	Power generation	8,280	6,044,400	12/20/1928
Morony Dam	Missouri River	Storage	3,981		12/20/1928

Source: DNRC Water Rights Records

Table 4-10. Missouri River flows (cfs) remaining after subtracting MPC water right claims

MPC FACILITY		MONTHLY FLOWS												
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hauser	Average	0	0	0	0	0	644	1032	1397	1229	113	0	0	368
Dam	10th %	773	846	1107	1133	1261	3370	4089	4663	4404	2933	676	751	2167
	20th %	672	702	847	620	895	2072	2631	3219	2933	1568	0	0	1347
	50th %	79	26	123	0	0	662	1063	1516	1288	0	0	0	396
	80th %	0	0	0	0	0	0	0	0	0	0	0	0	0
	90th %	0	0	0	0	0	0	0	0	0	0	0	0	0
Holter	Average	0	0	0	0	0	0	0	0	0	0	0	0	0
Dam	10th %	0	0	0	0	0	956	1469	2422	2507	912	0	0	689
	20th %	0	0	0	0	0	0	286	1284	1410	0	0	0	248
	50th %	0	0	0	0	0	0	0	0	0	0	0	0	0
	80th %	0	0	0	0	0	0	0	0	0	0	0	0	0
	90th %	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Eagle	Average	2407	2199	2128	1737	2038	3310	4245	7098	7800	3286	1254	1389	3241
Dam	10th %	3815	3887	3493	3754	3944	6204	7419	12487	14062	7534	3531	3310	6120
	20th %	3383	3301	3085	3255	3440	5214	6089	9834	10613	5880	2612	2576	4940
	50th %	2476	2116	2266	1593	1764	3268	4119	6731	6965	2489	651	930	2947
	80th %	1161	1137	1297	368	457	723	1932	3360	3198	206	0	283	1177
	90th %	499	155	215	0	56	336	608	2438	1562	0	0	23	491
Rainbow	Average	2207	1999	1928	1537	1838	3110	4045	6898	7600	3086	1054	1189	3041
Dam	10th %	3615	3687	3293	3554	3744	6004	7219	12287	13862	7334	3331	3110	5920
	20th %	3183	3101	2885	3055	3240	5014	5889	9634	10413	5680	2412	2376	4740
	50th %	2276	1916	2066	1393	1564	3068	3919	6531	6765	2289	451	730	2747
	80th %	961	937	1097	168	257	523	1732	3160	2998	6	0	83	994
	90th %	299	0	15	0	0	136	408	2238	1362	0	0	0	372
Cochrane	Average	0	0	0	0	0	0	0	398	1100	0	0	0	125
Dam	10th %	0	0	0	0	0	0	719	5787	7362	834	0	0	1225
	20th %	0	0	0	0	0	0	0	3134	3913	0	0	0	587
	50th %	0	0	0	0	0	0	0	31	265	0	0	0	25
	80th %	0	0	0	0	0	0	0	0	0	0	0	0	0
	90th %	0	0	0	0	0	0	0	0	0	0	0	0	0
Ryan	Average	157	0	0	0	0	1060	1995	4848	5550	1036	0	0	1221
Dam	10th %	1565	1637	1243	1504	1694	3954	5169	10237	11812	5284	1281	1060	3870
	20th %	1133	1051	835	1005	1190	2964	3839	7584	8363	3630	362	326	2690
	50th %	226	0	16	0	0	1018	1869	4481	4715	239	0	0	1047
	80th %	0	0	0	0	0	0	0	1110	948	0	0	0	172
	90th %	0	0	0	0	0	0	0	188	0	0	0	0	16
Morony	Average	0	0	0	0	0	0	0	2468	3170	0	0	0	470
Dam	10th %	0	0	0	0	0	1574	2789	7857	9432	2904	0	0	2046
	20th %	0	0	0	0	0	584	1459	5204	5983	1250	0	0	1207
	50th %	0	0	0	0	0	0	0	2101	2335	0	0	0	370
	80th %	0	0	0	0	0	0	0	0	0	0	0	0	0
	90th %	0	0	0	0	0	0	0	0	0	0	0	0	0

place the greatest constraint on water availability. Upstream from Cochrane Dam, water would not be available from August through March, and would be available in only about one year in ten during April through July and about five years in ten during May and June.

BUREC's Water Right Claims

BUREC operates six major storage and hydroelectric dams in the basin. Water right claims for these facilities are summarized in Table 4-11. BUREC supplies stored water to agricultural, municipal, and industrial users by means of water service contracts and also contracts for the release of water to MPC. BUREC and DFWP have informal agreements to coordinate operations of Clark Canyon, Canyon Ferry, and Tiber dams to benefit reservoir and stream fisheries, wildlife, and recreation (Spence 1990).

Canyon Ferry

The Missouri River basin upstream from Fort Peck Dam has experienced periodic water shortages over the past 60 years. In the 1930s, Montana water users became aware of the need for additional storage in the Missouri River Basin. This need was highlighted in 1942 when MPC brought suit against the Broadwater-Missouri Water Users Association complaining that new irrigation development would

Table 4-11. Summary of major BUREC claims in the Missouri basin

PLACE OF USE	SOURCE	TYPE OF USE	AMOUNT (cfs)	AMOUNT (af)	PRIORITY DATE
Canyon Ferry Dam[a]	Missouri River	Power generation	6,390	4,027,060	10/31/1898
Canyon Ferry Dam	Missouri River	Power generation	5,100	3,692,229	10/31/1898
Canyon Ferry Dam	Missouri River	Power generation	1,290	334,831	5/24/1949
Canyon Ferry Dam	Missouri River	Storage	29,055[b]	1,946,624	-
Canyon Ferry Dam	Missouri River	Irrigation	1,045	108,675	5/24/1949
Canyon Ferry Dam	Missouri River	Flood control	29,055	903,400	5/24/1949
Canyon Ferry Dam	Missouri River	Municipal	29,055	5,727	5/24/1949
Canyon Ferry Dam	Missouri River	Storage	29,055	1,946,624	5/24/1949
Canyon Ferry Dam	Missouri River	River regulation	29,055	1,946,624	5/24/1949
Canyon Ferry Dam	Missouri River	Fish and wildlife	29,055	1,946,624	5/27/1953
Canyon Ferry Dam	Missouri River	Recreation	29,055	1,946,624	5/27/1953
Tiber Dam	Marias River	Irrigation	81	9,567	8/21/1952
Tiber Dam	Marias River	Storage, future use	153,000	967,320	8/21/1952
Tiber Dam	Marias River	Flood control	153,000	709,139	8/21/1952
Tiber Dam	Marias River	Fish and wildlife	153,000	967,320	9/15/1952
Tiber Dam	Marias River	Recreation	153,000	967,320	9/15/1952
Pishkun Reservoir	Sun River	Irrigation	1,512	369,579	5/25/1905
Pishkun Reservoir	Sun River	Fish and wildlife	1,512	46,670	4/2/1921
Pishkun Reservoir	Sun River	Recreation	1,512	46,670	4/2/1921
Willow Creek Res.	Sun River/Willow Ck.	Irrigation	6,200	32,300	5/25/1905
Willow Creek Res.	Sun River/Willow Ck.	Fish and wildlife	6,200	32,300	5/25/1905
Willow Creek Res.	Sun River/Willow Ck.	Recreation	6,200	32,300	11/7/1911
Gibson Reservoir	Sun River	Irrigation	60,000	99,058	11/6/1917
Gibson Reservoir	Sun River	Fish and wildlife	60,000	99,058	12/31/1929
Gibson Reservoir	Sun River	Recreation	60,000	99,058	12/31/1929
Clark Canyon Res.	Beaverhead River	Irrigation	2,800	178,062	2/21/1961
Clark Canyon Res.	Beaverhead River	Flood control	2,800	129,526	2/21/1961
Clark Canyon Res.	Beaverhead River	Fish and wildlife	2,800	257,152	8/28/1964
Clark Canyon Res.	Beaverhead River	Recreation	2,800	257,152	8/28/1964

[a] MPC Claim Recognized
[b] Maximum rate of inflow
Source: DNRC Water Rights Records

adversely affect its hydropower water rights. The court concluded that MPC had water rights equal to the maximum discharge of its hydropower turbines. However, the appellate court dismissed the case on jurisdictional grounds, and, therefore, the lower court's determination has no legal significance. However, MPC has cited the finding of the lower court as evidence to support its hydropower water right claims.

This lack of water for future consumptive use was the primary reason for BUREC, MPC, and the Montana Water Board to study and then to seek Congressional authorization and finally construction of Canyon Ferry Dam. This project submerged Lake Sewell, a much smaller storage and hydropower project that was constructed in 1896 and bought by MPC which operated it from 1912 to 1949.

Development and funding of Canyon Ferry Reservoir and dam were obtained from the U.S. Congress through the Pick-Sloan Missouri River Basin Program in 1949. That same year BUREC bought the Lake Sewell project from MPC. The justification for Canyon Ferry was the need to satisfy the existing hydroelectric water rights of MPC, while at the same time providing water for new irrigation development.

Construction of Canyon Ferry Reservoir and dam began in 1951 and was completed in 1953. Hydroelectric generation at the 50-megawatt facility began in 1955. Canyon Ferry Reservoir was authorized to provide water for multiple purposes including irrigation, flood control, hydropower, municipalities, industry, fish and wildlife, and recreation. Water captured during spring runoff was to be released from storage to satisfy MPC's existing water rights, while providing a reliable supply of water for future irrigation and other consumptive uses both upstream and downstream. Even though over 430,000 acres of new irrigation projects were initially proposed for development using Canyon Ferry storage, only three projects (Helena Valley Irrigation District, the Crow Creek Pumping Unit, and the East Bench Irrigation District) were built, totaling 71,000 acres. In 1959, BUREC began supplying water to the Helena Valley Unit for irrigation. Following devastating floods in 1964 and 1965, the U.S. Army Corps of Engineers was allotted the top 3 feet of the reservoir exclusively for flood control.

BUREC has claimed water rights for power generation (direct flow and storage rights), irrigation, flood control, municipal, fish and wildlife, recreation, storage for future use or sale, and river regulation for power generation at Canyon Ferry and MPC's downstream power plants. BUREC's claimed water right for hydropower generation is 6,390 cfs, which is based on 5,100 cfs from MPC's original 1898 Lake Sewell water right and an additional 1,290 cfs to meet the capacity of its hydropower turbines. Helena Valley Irrigation District has claimed an additional 800 cfs which runs through a separate penstock at Canyon Ferry: 420 cfs of this total goes through a turbine to generate electricity to run the pump that diverts 380 cfs to the Helena Valley Irrigation Project. It is quite common for flows through the Canyon Ferry turbines to exceed 6,000 cfs when water is available. In recent years (1985-1991), water has spilled over the spillway without generating electricity only once, and that was for a two-week period in 1986.

When the Canyon Ferry site was transferred to public ownership in 1949, MPC retained a claimed water right (priority date of October 1889) to 47,500 af/y and 5,100 cfs of river water. BUREC agreed to let a fairly constant 5,000 cfs pass through the dam so that MPC's downstream power plants would have a reliable source of water. In practice, however, this release is rather flexible depending on water supply and day-to-day operations. MPC pays BUREC "headwater benefits" for releases from storage that allow MPC to generate more hydroelectric power than it could have before Canyon Ferry was built. In 1972, the Agreement for Coordination of Hydroelectric Operation between BUREC and MPC was signed. MPC and BUREC agreed that flows from the reservoirs and hydroelectric generation must be coordinated to achieve optimum power production from both systems at all times.

MPC is one of the primary beneficiaries from Canyon Ferry storage. Using its Missouri River Water Availability Model, DNRC estimated the amount of power MPC could generate at different levels of irrigation development. DNRC assumed that MPC would operate Hebgen Reservoir as it currently does (instead of operating as it did before Canyon Ferry was constructed) and also disregarded the effects of Lake Sewell (MPC's facility that was inundated by Canyon Ferry). Based on these assumptions, DNRC estimated MPC's average hydroelectric generation at the 1955 level of irrigation development with and without Canyon Ferry. These estimates are summarized in Table 4-12. The results show that on the average MPC annually generates 106 Gigawatt-hours or 5.6 percent more energy with Canyon Ferry reservoir than without it. Most of this additional energy is produced during December, January, February, March, August, and September with decreases occurring in May and June. At the 1986 level of development,

Table 4-12. Headwaters benefits to MPC's seven mainstem facilities from Canyon Ferry Reservoir (annual GWh)

Frequency of Occurence[a]	Column A 1955 LOD[b] Pre-CF[c]	Column B 1955 LOD Post-CF	Column C 1986 LOD Post-CF	Column D Headwater Benefits at 1955 LOD (Column B-Column A)	Column E Headwater Benefits at 1986 LOD (Column C-Column A)	Power Loss Between 1955 and 1986 (Column D-Column E)
1 year in 10	2,177	2,337	2,334	160	157	3
2 years in 10	2,145	2,291	2,260	146	115	21
5 years in 10	1,918	2,024	2,002	106	84	22
8 years in 10	1,612	1,631	1,611	19	-1	20
9 years in 10	1,469	1,476	1,444	7	-25	32
Average annual	1,884	1,990	1,968	106	84	22

[a] From highest to lowest energy-producing years
[b] LOD - Level of irrigation development
[c] CF - Canyon Ferry

MPC still produces on average of 84 Gigawatt-hours per year or 4.3 percent more electricity than it would have produced without Canyon Ferry (Table 4-12). Irrigation and other water use developments between 1955 and 1986 have decreased headwater benefits to MPC an average of 22 Gigawatt-hours or 21 percent annually. The results also suggest that in the two low-power years in ten, MPC may not receive headwaters benefits from Canyon Ferry storage at the 1986 level of development.

According to BUREC, stored water that is currently sold to MPC is available for appropriation through a water service contract with BUREC since the authorization for Canyon Ferry is to maintain MPC's power production at levels that existed before Canyon Ferry while providing enough water for future consumptive uses.

BUREC insists that Canyon Ferry Reservoir must be filled each year to contain carry-over storage to meet all demands during a 4-year critical period. This critical period is based on the four worst consecutive drought years that occurred in the 1930s. Even with these reservoir operational criteria, the drought of the late 1980s caused the reservoir to drop 23 feet below full pool. A recent study by Deluca (1987) was designed to ascertain whether Canyon Ferry reservoir operations could be modified to allow for more upstream irrigation development without reducing electric energy production and without adversely affecting recreation, fish, and wildlife within the reservoir. The results suggest that new irrigation could occur with only a slight decrease in power production, but that the risk of lowering the reservoir level may not be acceptable for recreation, fish, and wildlife purposes. DNRC's assessment of the proposed actions described in Chapter 6 is based in part on hypothetical modifications to the operation of Canyon Ferry Reservoir.

Murphy Rights

In 1969, the Montana Legislature authorized DFWP to file for instream or Murphy rights (named after James Murphy, a legislator who sponsored the bill) to protect flows on blue ribbon trout streams for fish and wildlife habitat. DFWP filed on six streams in the Missouri basin as summarized in Table 4-13. Like other pre-1973 claims, Murphy rights are undergoing review in the adjudication process. The District Court can reallocate these instream rights if it determines that the new use is more beneficial to the public. Because of this, Murphy rights may or may not affect water availability for future consumptive uses.

Other Major Claims

DNRC and a number of private groups operate reservoirs in the basin, primarily to store water for irrigation. Table 4-14 provides a summary of such reservoirs storing 5,000 acre-feet or more. These reservoirs have water rights senior to reservations.

Fort Peck Reservoir

The U.S. Army Corps of Engineers has water right claims associated with the operations of Fort Peck Reservoir. Based on the maximum power plant

Table 4-13. Summary of DFWP "Murphy rights" in the Missouri basin

STREAM	REACH	DATES	AMOUNT (cfs)
Madison River	Hebgen Dam to Quake Lake	4/1-7/31	50
		8/1-3/31	500
Madison River	Quake Lake to mouth of West Fork	1/1-12/31	500
Madison River	Mouth of West Fork to Ennis Lake	1/1-5/31	900
		6/1-7/15	1400
		7/16-12/31	1050
Madison River	Ennis Lake to mouth	1/1-5/31	1200
		6/1-6/30	1500
		7/1-7/15	1423
		7/16-12/31	1300
West Gallatin River	Yellowstone Park to Gallatin Gateway	5/16-7/15	800
		7/16-5/15	400
Gallatin River	Mouth to junction with East Gallatin River	5/1-5/15	947
		5/16-5/31	1278
		6/1-6/15	1500
		6/16-6/30	1176
		7/1-8/31	850
		9/1-4/30	800
Missouri River	Toston Dam to Canyon Ferry Reservoir	1/1-1/31	1500
		2/1-5/15	3000
		5/16-6/30	4000
		7/1-7/15	3816
		7/16-9/14	1500
		9/15-12/31	3000
Smith River	Fort Logan Bridge to confluence of Sheep Creek	5/1-6/30	150
		7/1-4/30	90
Smith River	Confluence of Sheep Creek to Cascade-Meagher county line	4/1-4/30	140
		5/1-6/30	150
		7/1-8/31	140
		9/1-3/31	125
Smith River	Cascade-Meagher county line to confluence of Hound Creek	5/1-5/15	372
		5/16-6/15	400
		6/16-6/30	398
		7/1-4/30	150
Big Spring Creek	State Fish Hatchery to mouth of Cottonwood Creek	1/1-12/31	110

Source: DNRC Water Rights Records

capacity of 16,000 cfs and the average daily outflow between 1967 and 1990, the reservoir has only exceeded this capacity in six months during the 24-year period. This indicates that Fort Peck rarely spills water, and almost all of it is used to generate hydroelectricity. A preliminary decree has been issued for the basin in the vicinity of Fort Peck Dam and Reservoir, which lists the corps' right as 11,700,000 af/yr at a rate of 20,000 cfs for power generation. The nature and extent of this right will not be determined until after the water court issues a final decree. This claim may have major ramifications on upstream water availability. Under the 1944 Flood Control Act, it is not known whether these claims for hydropower would limit new irrigation development.

Federal Reserved Rights

The federal government and Indian tribes claim reserved water in the basin for consumptive and instream uses. Reserved water rights are usually resolved either by a compact between state and tribe or federal agency, or through litigation. To date, the only federal reserved claims that have been resolved in the Missouri basin are those on the Fort Peck Indian Reservation.

Indian Tribes

In 1908, the U.S. Supreme Court recognized reserved water rights for tribes on Indian reservations. Winters v. United States, 207 U.S. 564, 28 S. CT. 207, 52 L.Ed 340 (1908). Map 4-2 shows Indian reservations where reserved rights have been claimed. Several tribes claim unspecified quantities of water in the basin for "aboriginal rights" with a priority dating from "time immemorial." Board of Control of Flathead Irr. D. V.,Et Al., United States, 832 F.2d 1127, 1131 (9th Cir. 1987). The following is a summary of claimed reserved water rights by Indian tribes in the basin and their status.

Blackfeet

The Blackfeet Reservation is located in the northwestern portion of the basin and includes areas drained by the Two Medicine River and Badger, Birch, Blacktail, and Cut Bank creeks. The Blackfeet Tribe has filed claims with the state for existing water uses which are summarized by drainage basin in Table 4-15. The tribe also has claimed "all waters arising upon, flowing by, through, or under the Reservation"

Table 4-14. Missouri basin reservoirs with a total capacity of more than 5,000 acre-feet

NAME	SUBBASIN	STREAM	APPROXIMATE MAX. STORAGE (acre-feet)	NORMAL STORAGE (acre-feet)	SURFACE AREA (approx. acres)	PURPOSE CONSTRUCTED[a]	Owner
Ackley Lake	Middle	Offstream Judith River	7,990	5,970	250	I	State of Montana
Bair	Middle	North Fork Musselshell	10,650	7,020	252	I	State of Montana
Broadwater-Toston	Upper	Missouri River	6,460	4,100	360	I, P, R	State of Montana
Bynum	Marias	Offstream Teton River	107,000	87,000	4,120	I	Teton Reservoir Co.
Canyon Ferry	Upper	Missouri River	2,051,000	1,947,000	35,200	I,FC,FW,P	BUREC
Clark Canyon	Headwaters	Beaverhead River	257,000	178,000	10,000	I, FC, FW	BUREC
Cochran	Upper	Missouri	9,900	8,720	270	P	MPC
Deadman's Basin	Middle	Offstream Musselshell	100,000	76,800	2,042	I	State of Montana
Delmoe lake	Headwaters	Big Pipestone Creek	9,900	6,800	479	I	Pipestone Water Users
East Fork	Middle	East Fork Big Spring Creek	5,297	5,004	226	FC, R	City of Lewistown
Ennis Lake	Headwaters	Madison River	60,000	37,000	3,800	P	MPC
Eureka	Marias	Teton River	6,200	5,500	400	I	Teton Canal
Fort Peck	Middle	Missouri River	19,410,000	13,915,000	245,000	FC,P,I,N,M	Corps of Engineers
Four Horns	Marias	Badger Creek	30,000	20,000	897	I	BIA
Gibson	Upper	Sun River	105,000	104,800	1,360	I, FW	BUREC
Hauser Lake	Upper	MissouriRiver	109,470	56,140	3,800	P	MPC
Hebgen Lake	Headwaters	Madison River	525,000	273,000	12,668	P	MPC
Helena Regulating	Upper	Offstream Missouri River	10,700	10,500	610	I, M	BUREC
Holter Lake	Upper	Missouri River	265,000	245,000	4,800	P	MPC
Hyalite	Headwaters	Hyalite (Middle Creek)	10,230	7,780	212	I	State of Montana
Lake Francis	Marias	Offstream Dupuyer and Birch Creeks	133,000	105,000	5,536	I	Pondera Canal
Lake Helena	Upper	Missouri River and Prickly Pear Creek	49,047	8,160	1,630	Storage, P	MPC
Lima	Headwaters	Red Rock River	133,000	84,050	6,400	I	Lima Water Users
Lower Two Medicine	Marias	Two Medicine Creek	2,100	13,500	806	I	BIA
Martinsdale	Middle	Offstream South Fork Musselshell River	36,030	23,080	1,050	I	State of Montana
Mission Lake	Marias	Spring Creek (near Cut Bank)	5,200	5,200	1,390	R	Blackfeet Indian Res.
Morony	Upper	Missouri River	1,300	7,800	300	P	MPC
Newlan Creek	Upper	Newlan Creek (Meagher)	15,600	12,230	327	I,FC,FW,R	Newlan Creek Water
Nilan	Upper	Offstream Smith and Ford Creeks	15,600	10,100	535	I	State of Montana
North Fork Smith (Sutherlin)	Upper	North Fork Smith River	14,200	11,500	335	I	State of Montana
Petrolia	Middle	South Fork Flatwillow Creek	14,170	9,192	515	I	State of Montana
Piskun	Upper	Offstream North Fork Sun River	46,700	46,700	1,550	I	BUREC
Red Rocks Lake	Headwaters	Red Rocks River	19,960	19,960	8,480	FW	USFWS
Ruby	Headwaters	Ruby River	58,400	38,850	970	I	State of Montana
Swift	Marias	Birch Creek	34,000	30,000	455	I	Pondera County Canal
Tiber	Marias	MariasRiver	1,368,000	967,300	22,180	I,FC,FW,M	BUREC
Warhorse Lake	Middle	Offstream Ford Creek	21,750	12,750	1,560	I	State of Montana
Whitetail	Headwaters	Whitetail Creek (near Butte)	6,200	4,000	830	I	Whitetail Water Users
Willow Creek (near Simms)	Upper	Offstream Sun River	32,400	32,230	1,450	I, FW	BUREC
Willow Creek (near Harrison)	Headwaters	Willow Creek	26,600	18,000	850	I	State of Montana
Yellow Water	Middle	Yellow Water Creek	8,100	4,500	700	I	State of Montana
		TOTAL	25,197,654	18,524,636	385,785		

[a] I — Irrigation, FC — Flood Control, FW—Fish and Wildlife, P—Power, M—Municipal, R—Recreation, N—Navigation

Sources: Missouri River Basin Commission 1981 and Montana DNRC Dam Safety Data Base 1990d

Map 4-2. Locations of Montana Indian reservations

and "all appropriative water rights previously acquired, and/or water rights appurtenant to lands, owned by allottees and all tribal members who have an interest in lands within the Blackfeet Indian Reservation." The priority date claimed for Blackfeet water rights is May 1, 1888, the date the Blackfeet Reservation was created.

Table 4-15. Summary of major claims by the Blackfeet Tribe in the Missouri basin

SOURCE	TYPE OF USE	AMOUNT (cfs)	AMOUNT (af)
Cut Bank Creek	Irrigation	1,350	572,022
Badger Creek	Irrigation	234	100,000
Birch Creek	Irrigation	700	296,604
Blacktail Creek	Irrigation	500	211,860
Two Medicine River	Irrigation	1,000	433,720
Guardipee Reservoir	Irrigation	-	70,000
Lower Two Medicine River	Irrigation	-	100,000
Spring Lake	Irrigation	117	50,000
Middle Two Medicine River	Irrigation	395	167,686

Source: DNRC Water Rights Records

The Blackfeet Tribe will probably not negotiate the extent of their reserved water rights with the State of Montana Reserved Water Rights Compact Commission. Therefore, it is likely that their rights will be quantified in court. It is unlikely that reserved water rights of the tribe will be settled before the Board acts on the proposed water reservations. These claimed rights could have a significant effect on water availability in the Marias drainage above Tiber Reservoir.

Fort Belknap

Most of the Fort Belknap Indian Reservation lies within the Milk River basin; only a small portion of it is within the area being addressed in this draft EIS. The tribe filed claims for some water in the Milk basin, and the State of Montana Reserved Water Rights Compact Commission and Tribes of the Fort Belknap Reservation are currently negotiating the quantification of these rights. It is unlikely that these negotiations will be completed before the water reservation applications are acted on by the Board. The date the Fort Belknap Reservation was formed and priority date claimed for any associated reserved water rights is May 1, 1888.

Effects on legal water availability in the basin upstream from Fort Peck Dam probably will be minor.

Turtle Mountain

The Turtle Mountain Indian Reservation is located in North Dakota. Pursuant to an agreement between the Tribes of the reservation and the federal government in 1892 and the agreement's subsequent ratification in 1904, parcels of land scattered throughout the Dakotas and Montana were held in trust for individual Turtle Mountain tribal members. No negotiations are under way regarding reserved rights for these parcels. Reserved rights for these parcels could have local effects on legal water availability, and 1,120 acres of this land is located within irrigation projects proposed by the applicants in the Marias/Teton drainage.

Fort Peck Reservation

The Fort Peck Reservation is located north of the Missouri River downstream from Fort Peck Dam. A compact was negotiated in 1985 between the tribes of the Fort Peck Reservation and the Montana Reserved Water Rights Compact Commission allowing the tribes to divert 950,000 acre feet per year from reservation surface water sources, primarily the Missouri River. Maximum rates of diversion from the Missouri River are as follows:

Jan.	- 650 cfs	July	- 3,497 cfs
Feb.	- 720 cfs	Aug.	- 2,928 cfs
Mar.	- 650 cfs	Sept.	- 1,765 cfs
Apr.	- 840 cfs	Oct.	- 813 cfs
May	- 1,708 cfs	Nov.	- 672 cfs
June	- 2,437 cfs	Dec.	- 650 cfs

The Fort Peck Reservation was formed on May 1, 1888, which is the priority date for these compacted rights. The diversion schedule in the compact was developed with the cooperation of the U.S. Army Corps of Engineers and reflects the past operation of the Missouri River system. These rights have the potential to affect development of water upstream because they are large and have an early priority date.

Other Tribal Claims

The Blackfeet, Chippewa-Cree, Assiniboine-Gros Ventre, Sioux, Northern Cheyenne, and Crow Indian tribes have claimed "all those waters in the state of Montana necessary for those aboriginal rights recognized and guaranteed pursuant to various treaties." A similar claim by the Confederated Salish and Kootenai Tribes is for "all those waters in the State of Montana necessary for the protection of those aboriginal rights recognized and guaranteed pursuant to the treaty of Hellgate, Montana, July 16, 1855." It is not known how or when such aboriginal claims will be resolved or how these claims may affect water availability.

Federal Agencies

U.S. Forest Service

National forests within the area being considered in this EIS include the Beaverhead, Deerlodge, Gallatin, Helena, Lewis and Clark, and Flathead. USFS is negotiating with the Reserved Water Rights Compact Commission and asserts instream rights on a large number of streams for watershed protection. Such claims may affect the availability of water for new diversions from headwater streams within national forests. However, these claims would not affect the availability of water downstream from the forest boundaries.

U.S. Bureau of Land Management

In October 1976, the 149-mile reach of the upper Missouri River from Fort Benton downstream to the Fred Robinson Bridge was designated a component of the National Wild and Scenic River System. This river reach is administered by BLM under the provisions of the National Wild and Scenic Rivers Act (PL 94- 542). It is also managed for multiple use and sustained yield under the principles of the Taylor Grazing Act (PL Stat. 1269 as amended), Federal Land Management Policy Act (PL 94-579), and the Amendment to the Wild and Scenic Act specific to the Upper Missouri Wild and Scenic River (PL 94, Sec. 202 and 203).

BLM with the assistance of DFWP identified flow requirements for the wild and scenic reach (BLM, 1984). The instream flows claimed by BLM, listed in Table 4-16, are based on the following criteria: side channel threshold flows for critical rearing and forage-fish production between June 1 and August 31; adequate flows in riffle areas for food production, and critical habitat and migration routes for certain fish throughout the year; flows to protect Canada goose nesting sites between March 15 and June 1; paddlefish migration flows between May 19 and July 5; recreation flows for boats, rafts, canoes, and kayaks from May 15 to November 15; and flushing flows to maintain channel stability for an average of 16 days between March 15 and July 15.

Over the past 10 years, BLM has held preliminary discussions for negotiating a federal reserved water right for these flows with Montana's Reserved

Table 4-16. Summary of reserved claims by BLM for the Wild and Scenic section of the Missouri River

STREAM REACH	TIME PERIOD	RECOMMENDED STREAMFLOW (cfs)
Fort Benton to Confluence of the Marias River	3/15-5/14	4,887
	5/15-5/18	6,390
	5/19-7/5	12,622
	7/6-7/15	6,390
	7/16-8/31	4,500
	9/1-11/15	4,480
	11/16-3/14	4,887
	16 days between 3/15 and 7/15 (channel stability flows)	21,200
Confluence of the Marias River to confluence of the Judith River	3/15-5/14	5,571
	5/15-5/18	7,470
	5/19-7/5	14,000
	7/6-7/15	7,470
	7/16-8/31	5,400
	9/1-11/15	5,150
	11/16-3/15	4,305
	16 days between 3/15 and 7/15 (channel stability flows)	22,600
Confluence of Judith River to Fred Robinson Bridge	3/15-5/14	7,100
	5/15-5/18	8,300
	5/19-7/5	15,187
	7/6-7/15	8,300
	7/16-8/31	5,800
	9/1-11/15	5,600
	11/16-3/15	4,700
	16 days between 3/15 and 7/15 (channel stability flows)	26,200

Source: BLM 1984

Water Rights Compact Commission. Negotiations between the state and BLM regarding these reserved water rights have been postponed while a model of the historical flows and historical uses in the basin is being developed. The effect on water availability of BLM's proposed reserved water right for instream flows at Fort Benton, Virgelle, and Landusky is shown in Table 4-17. The results indicate that BLM's proposed water right would have slightly less impact on water availability than MPC's claimed right for hydropower at Cochrane Dam except during June in a few years (Table 4-10). MPC's claimed hydropower water right at Cochrane Dam is less than 38 miles upstream of the beginning of the wild and scenic stretch at Fort Benton. The priority date for the flows would be October 12, 1976, when congress authorized the wild and scenic designation.

National Park Service

Within the basin, the National Park Service is claiming reserved rights to instream flows for streams arising in Yellowstone and Glacier national parks, though these should not be affected by the proposed reservations. The National Park Service is also claiming reserved water rights for the Big Hole Battlefield on the Big Hole River. There are no active negotiations between the state and park service regarding these claims, and it is not known at this time if they will be resolved before the Board acts on the reservation applications.

U.S. Fish and Wildlife Service

USFWS is negotiating a compact to settle reserved rights within the basin on the Benton Lake and Charles M. Russell national wildlife refuges. Claims for the refuges are relatively minor, and their resolution should not have a effect on the legal availability of water for future appropriation except at a local level.

WATER STORAGE

Today, about 8,500 storage projects covering 400,000 surface acres have been built in the Missouri River basin upstream from Fort Peck Dam. These projects provide many different benefits to basin users. Reservoirs can regulate streamflows for flood control; store water for irrigation, municipal, industrial, and stockwater use; provide opportunities for flatwater recreation; improve fisheries; and supply water for hydropower generation. Storage facilities, however, also can have adverse impacts on recreation and aquatic and riparian habitat associated with free-flowing rivers and can alter aesthetic views.

The size of basin storage projects range from a few acre-feet in stock water ponds to over 19 million acre-feet in Fort Peck Reservoir. Total storage capacity in the basin is estimated to be about 26 million acre-feet. About 96 percent of the water stored in the basin is in 42 medium and large reservoirs (Table 4-14). Each of three reservoirs, Fort Peck, Canyon Ferry, and Tiber, holds more than 1 million acre-feet, and together they store over 88 percent of the basin's capacity in normal years. With the exception of private hydropower projects, essentially all large water storage projects in the basin have been built by and financed primarily by the federal government (DNRC Water Storage Report 1989).

Table 4-17. Missouri River flows (cfs) remaining after subtracting BLM's proposed federal reserved water rights for the Missouri Wild and Scenic River stretch

		MONTHLY FLOWS[a]												
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG.
Fort Benton to Marias River	Average	1433	1179	939	580	915	2180	3216	3305	0	888	405	603	1304
	10th %	2937	2862	2375	2600	2833	5138	6374	9384	7582	5518	2673	2764	4420
	20th %	2609	2130	2011	2168	2568	4511	5269	6430	3171	3134	1580	1755	3111
	50th %	1216	1081	972	489	698	2241	3044	2910	0	0	0	149	1067
	80th %	130	99	0	0	0	0	814	0	0	0	0	0	87
	90th %	0	0	0	0	0	0	0	0	0	0	0	0	0
Marias River to Judith River	Average	1528	2044	2252	1832	2300	3115	3614	4481	748	1192	391	744	2020
	10th %	3321	3914	4099	3924	4750	6611	7444	10328	7943	6670	3022	3435	5455
	20th %	2884	3203	3436	3661	3835	5442	6163	8659	4929	4800	1871	2137	4252
	50th %	1459	2014	2424	1757	2238	3227	3397	3911	0	49	0	12	1707
	80th %	213	882	1077	0	146	87	950	264	0	0	0	0	302
	90th %	0	0	0	0	0	0	0	0	0	0	0	0	0
Judith River to Fred Robinson Bridge	Average	1532	2170	2303	1829	2450	3408	5597	4399	1424	1662	508	779	2338
	10th %	3226	3675	4009	4464	5342	7677	10540	12149	10292	7624	3297	3602	6325
	20th %	3063	3222	3858	3511	4651	5772	8798	8211	5395	5450	2152	2323	4701
	50th %	1445	2146	2469	1760	2471	3169	4969	4057	367	392	75	39	1947
	80th %	157	1103	981	0	62	0	2520	0	0	0	0	0	402
	90th %	0	261	0	0	0	0	811	0	0	0	0	0	89

[a] All streamflows were estimated using the Missouri River Water Availability Model

Modifications to storage facilities for hydropower are ongoing or proposed in the basin. A hydropower turbine is proposed for Tiber Dam on the Marias River by three different groups. Over the last 10 years, legal arguments have been made before FERC and the Montana Supreme Court about who will receive authorization by FERC to build the facility on this Bureau of Reclamation dam. Also, the U.S. Army Corps of Engineers has recently studied the potential for adding two hydropower generation units to Fort Peck Dam. This addition appears to be economically feasible, but a number of environmental problems have been identified that must be mitigated. The Corps has decided not to pursue this project until there are state or local sponsors. MPC also proposes modifications to its facilities as indicated in Table 4-56.

Two existing dams will be modified. Middle Creek Dam on Hyalite Creek near Bozeman is being enlarged by 1,800 acre-feet to meet Bozeman's municipal needs and for supplemental irrigation. The inadequate spillway will be replaced and recreational facilities around the reservoir will be improved. The other activity is to repair the unsafe spillway on Lima Dam located on the Red Rock River in Beaverhead County.

A new storage project on Ruby Creek, a tributary of the Big Hole River, is being considered. The project is intended to store water to supplement late season irrigation on 5,000 acres and to provide instream flows for the downstream fishery and recreation. Funding for a feasibility study of the project is being sought from DNRC's Water Development Program.

The issue of water storage was taken through the state water planning process in 1988-90 and three primary components were addressed: policy, financing, and regulation. Recommendations in the completed plan section were included in legislation that passed in April 1991. The legislation clarified water storage policy, defined the role of storage in solving water problems, and established guidelines for setting priorities among new storage and rehabilitation storage projects. A special water storage account was created with revenues to be used in line with the following priorities: (1) rehabilitation of high hazard and unsafe dams; (2) enlargement and rehabilitation of other existing water storage projects; and (3) construction of new storage projects.

WATER QUALITY

Basin-wide Overview of Water Quality

Snowmelt from mountain watersheds provides most of the annual runoff in the basin. This runoff water is generally cool and moderately soft, but nutrients, salts, and water temperature in the Missouri gradually increase as the river travels from the mountains to the plains. Water degradation with distance downstream is due primarily to loss of water through evaporation from reservoirs, canals, and streambeds, uptake by plants, contamination by soluble minerals from soils and underlying rock formations, and pollution by humans.

The State of Montana classifies streams by water use. Waters of the Missouri River basin above Fort Peck Dam are classified from A-closed (highest quality) on down through A-1, B-1, B-2, B-3, C-1, C-2, and C-3 to I (lowest quality) (Table 2-1). The waters are classified by their suitability for drinking, processing food, bathing, swimming, propagation and growth of fish and aquatic life, waterfowl and furbearers, and agricultural and industrial water use. Most of the Missouri Basin water is in the B classification. A listing of the streams with their classification and notable impairments is found in Appendix E.

In dry years (such as those during the drought of the 1980s), water quality problems are more pronounced, particularly in streams affected by waste discharges and depletion. For example, dissolved chemical concentrations and water temperatures are highest during these low flow periods. In contrast, suspended sediments follow a reverse pattern with highest concentrations at high flows.

Irrigation is a large contributor of non-point pollution in the basin (DHES 1990). Water quality problems typically result when diversion of irrigation water creates low flows and when return flows are polluted by salts, nutrients, and sediments.

Groundwater quality is generally excellent in alluvial aquifers along major streams in the basin. However, water in deeper bedrock aquifers is generally of poorer quality. Naturally high concentrations of total dissolved solids, sulfate, iron, fluoride, nitrogen, and trace elements are present due to the length of time that groundwater is in contact with rocks and earth containing these materials. Large portions of the basin are underlain by younger geologic sediments that contain aquifers in the Hell Creek, Judith River, Kootenai, and Fort Union formations. Water quality in these aquifers is locally variable but generally is characterized by hardness, high salt content, metals, and generally poor quality, particularly at greater depths. The Madison limestone, a large-volume deep aquifer, is very thick, with outcroppings throughout central Montana. Depending on location, its water quality varies from excellent to very poor.

Although water quality is generally good in the basin, local and regional problems impair water use. Such problems include elevated temperatures, suspended sediment, salinity, high nutrients, alkalinity, trace elements (arsenic particularly), metals, and low dissolved-oxygen levels. The more important parameters are discussed below.

Parameters of Concern

Total Dissolved Solids

Total dissolved solids (TDS), a measure of salinity in water, is one of the few water quality indicators for which substantial data exist. Salt tolerance of crops depends on chemical and physical characteristics of soils and the relative proportions of specific ions such as sodium, magnesium, calcium, and boron. TDS in excess of 500 mg/L may not be used for human consumption. Livestock is less sensitive to salts than humans and wildlife, but will generally not drink water if TDS concentrations exceed 2,000 mg/L. Sensitivity of aquatic organisms to salts is difficult to generalize because of wide variability among organisms. TDS levels above 1,000 mg/L would render water unusable for irrigation. At saline seep locations, TDS concentrations in groundwater range from 15,000 to 55,000 mg/L.

Total Suspended Sediment

Total suspended sediment (TSS) is a measure of all sediments and organisms suspended in a stream. Turbidity, as measured by the ability of light to penetrate water, is generally closely associated with suspended sediments. There is no public drinking water limit for TSS. TSS is an important indicator of the overall condition of a stream. Storms, changes in land management practices, or water released from storage can increase erosion, resulting in high turbidity. Applying irrigation water high in TSS will reduce infiltration rates, making soils less permeable. Fine sediment in streams may also harm aquatic life by clogging gravel streambeds important to aquatic life and by abrading the gills of fish and other organisms.

Biological Oxygen Demand

Biological oxygen demand (BOD) is a measure of the oxygen required by microorganisms to degrade organic matter in water. More oxygen is needed when organic matter increases. Treated wastewater is required to meet standards for BOD because biological degradation of organic compounds from sewage uses oxygen and thereby reduces its concentrations below levels needed to support aquatic organisms.

Dissolved Oxygen

Certain levels of dissolved oxygen are necessary to sustain aquatic life. DHES's dissolved oxygen standard for protecting warm water aquatic life is 5.0 mg/L, and 7.0 mg/L for cold water organisms. Nitrogen and phosphorus can act as fertilizers and increase the growth of algae in streams. Increased algae growth increases the demand for dissolved oxygen, lowering the dissolved oxygen level in streams. Dissolved oxygen concentrations also are affected by stream temperatures; as stream temperatures rise, oxygen concentration decreases.

Arsenic

Arsenic, a trace element known for its short-term and long-term health effects, is a carcinogen. Recently it has come under increasing regulatory attention from both EPA and DHES. A confusing aspect of arsenic involves two apparently contradictory water quality standards. Based on human health studies, federal drinking water standards limit arsenic to 50 micrograms per liter (µg/L or parts per billion) in treated water supplies. This standard, initially adopted in 1946, is being reviewed by EPA. It is likely that the concentration allowed in drinking water will be significantly reduced, but to what level is not known at this time. At the other end of the spectrum, the Board of Health and Environmental Sciences in 1990 adopted an instream standard that is based on EPA's one-case-per-million risk level for carcinogens. In contrast to the 50 micrograms per liter (parts per billion) standard for drinking water, this standard will not allow activities that increase arsenic in surface water with an arsenic concentration exceeding 20 nanograms per liter (parts per trillion).

It is widely recognized that the Missouri River above Fort Peck exhibits high concentrations of arsenic. High levels of arsenic originate naturally within geothermal springs along the Firehole River, a tributary of the Madison River, in Yellowstone National Park. The range of arsenic concentrations in the upper Madison and Missouri rivers is shown in Table 4-18.

Table 4-18. Summary of arsenic concentrations in the upper Madison and Missouri rivers

	Arsenic concentration (µg/L)		
	Minimum	Median	Maximum
Madison River near West Yellowstone	137	258	370
below Hebgen Lake	78	120	240
below Ennis Lake	48	73	100
at Three Forks	42	68	88
Missouri River at Toston	10	30	100[a]
below Canyon Ferry Dam	23	28	34
near Landusky	1	2	52

[a] Dissolved arsenic concentration

Notes: µg/L = parts per billion (ppb)
1 part per billion exceeds BHES standard by 50 times. Except where noted, all values are total arsenic concentration.

Source: USGS 1987

A recent investigation by Sonderegger et al. (1989) shows that irrigation of the lower Madison Valley with Madison River water has resulted in contamination of alluvial and Tertiary aquifers underlying the valley. Dissolved arsenic concentrations typically range from 80 to 150 µg/L in the near-surface (water table less than 100 feet) alluvial aquifers, which have been recharged by irrigation for more than 100 years.

A systematic survey of arsenic concentrations in groundwater has not been conducted. Although it is doubtful that the degree of groundwater contamination along the Missouri River is as great as in the Madison valley, there is potential for locally elevated arsenic concentrations in shallow groundwater supplies along the Missouri River.

Nutrients

Increases in phosphorous (P) and nitrogen (N) can degrade water quality and can lead to increased algae growth. Flood irrigation of fertilized fields typically flushes a portion of these nutrients into streams and groundwater. If irrigation is properly scheduled or sprinkler methods are integrated with soil moisture conditions, nutrients are less likely to affect surface waters.

Nitrogen compounds are found everywhere in nature and are released as soluble nitrate to groundwater under a complex variety of conditions. Notable sources of concentrated nitrates are fertilizers, feedlots, mining operations where nitrogen blasting

compounds are used, sewage effluent, the atmosphere, chemical spillage, and agricultural runoff. The public drinking water standard for nitrogen is 10 mg/L.

Phosphorus is an essential element for aquatic life but can cause water quality problems if its concentrations become too high. Reservoirs will collect phosphates from influent streams, and these are stored within lakebed sediments where they can reenter the water when dissolved oxygen levels become low. Major sources of phosphorus in the Missouri basin are sediments, domestic sewage effluents (including detergents), processing wastes, and agricultural runoff, including fertilizer residues and animal wastes. Total phosphorus allowed by DHES standards is 0.10 mg/L in streams.

The ratio of nitrogen and phosphorus can affect the rate of algae growth. In normal stream conditions a 10:1 ratio of N to P is common, but ratios can range from 2:1 to 100:1. Abnormal balances of this ratio combined with high water temperatures and the presence of different algae species can trigger algal blooms. Available phosphorus present in concentrations between 0.01 and 0.05 mg/L is thought to be favorable for algal blooms in lakes. Research shows that algal blooms occur most often when nitrogen exceeds 0.3 mg/L and phosphorus exceeds 0.01 mg/L (Novotny and Chesters 1981).

Hard water, summer heat, and high nutrient concentrations combine to produce ideal conditions for algal blooms in streams and lakes. Algal blooms generally occur where summer heat warms shallow water in lakes, ponds, and reservoirs to temperatures above 68 degrees Fahrenheit (DHES 1984). As algae populations expand, dissolved oxygen decreases.

Although rare, there are toxic strains of algae that can be more than just a nuisance. *Anabaena flos aquae* (blue-green algae) have produced a deadly toxin in Hebgen Reservoir and Canyon Ferry Lake in the last decade. These algae can paralyze muscles and kill livestock. These and other toxic blooms last only a few days and cannot readily be distinguished from non-toxic algae that exist in most shallow waters. Seventeen cattle died near Hebgen Reservoir in June 1985, and 39 were killed eight years earlier in the same area from toxic blooms of blue-green algae. In August 1984, a toxic bloom killed eight cows, a bull, and a calf on the northwest edge of Canyon Ferry Lake.

Toxic strains of algae are rare, but there is no way to predict when and where they will appear. The bloom often lasts a few days to a week and disappears, leaving only the loss of animals, fish, and recreational dollars (DHES 1984). Acute toxicity to humans has not been documented, but there is increasing evidence that the toxins cause gastroenteritis, and with contact, skin irritation to humans.

Water Temperature

Many factors affect water temperatures including exposure to the sun, water depth and velocity, air temperature, precipitation, groundwater inflows, and the temperature of water from irrigation, springs, or water storage projects. Reduced streamflows generally can result in elevated stream temperatures. Water temperatures that exceed 67°F (14.4°C) can harm some forms of aquatic life. Summer temperatures in some Missouri basin streams presently exceed this level. Elevated stream temperatures also can reduce dissolved oxygen levels in streams, which in turn can harm aquatic organisms. Elevated water temperatures play a significant role in toxic algal blooms.

Statistical summaries of water quality data for selected USGS water monitoring stations are given in Table 4-19.

Headwaters Subbasin

The Jefferson, Madison, and Gallatin rivers and their major tributaries are classified A or B; most streams are B-1 and support a wide variety of uses. These headwater streams generally are of good quality, having low concentrations of dissolved solids and being slightly alkaline.

Notable problems in the Headwaters Subbasin include low flows, sedimentation, elevated water temperature, acid mine drainage, and high arsenic concentration. Low flows are a significant problem on the Beaverhead, Big Hole, Gallatin, and Jefferson rivers in dry years, causing elevated stream temperatures, increased algae, and reduced dissolved oxygen. Arsenic concentrations on the Madison River exceed both the instream and the drinking water standard.

A variety of pollutants enters the East Gallatin River from municipal and agricultural sources. Critical low flows occur during summer months and limit the dilution capability of the river. The West Gallatin, West Fork Madison, and Jefferson rivers all have

sedimentation problems resulting from a combination of natural and human-caused factors. Solar heating of reservoirs and stream depletion caused by irrigation contribute to elevated summer temperatures on the Beaverhead and Madison rivers. These temperatures can harm cold-water aquatic life. Aquatic life in the Boulder River is impaired by acid-mine drainage and toxic metals, a legacy of past mining.

Upper Missouri Subbasin

Water in the Upper Missouri Subbasin is suitable for most uses, but there is evidence that some tributaries are being severely polluted. Dissolved oxygen concentration is typically near the limit of the standard. Dissolved metals may be present in toxic concentrations in some drainages due to past mining activity. The tributaries generally have low

Table 4-19. Water quality data for selected USGS water monitoring stations in the Missouri basin[a]

	Total Dissolved Solids (mg/L)	Water Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Total Suspended Sediment (mg/l)	Total Arsenic μg/l
Headwaters Subbasin						
Madison River below Ennis Lake (7-18-72 to 10-24-90)[b]	190.0[c] (143-224)[d]	9.0 (0.5-22)	8.0 (7.2-8.5)	9.3 (7.8-11.8)	—[e]	73 (48-100)
Jefferson River near Twin Bridges (3-15-60 to 9-30-72)	301.0 (83-448)	9.0 (0-19)	7.8 (6.7-8.5)	—	28 (2-1,300)	—
Big Hole River near Melrose (8-3-60 to 9-1-64)	125 (57-186)	—	7.3 (6.8-8.1)	—	53 (5-365)	—
Beaverhead River near Twin Bridges (7-8-72 to 9-10-80)	418 (320-548)	8.7 (16.0-21.1)	8.0 (16-8.4)	—	—	—
Upper Missouri Subbasin						
Missouri River at Toston (6-9-65 to 12-7-89)	242 (123-300)	7.5 (0.0-22.5)	8.3 (7.3-8.8)	10.9 (7.9-13.8)	20 (5-491)	28 (8-100)
Missouri River below Canyon Ferry Dam (10-1-67 to 10-8-87)	220 (185-282)	—	—	—	—	28 (22-34)
Sun River near Vaughn (10-1-68 to 10-15-90)	´471 (156-1,100)	—	8.1 (7-8.8)	—	—	—
Muddy Creek at Vaughn (10-1-67 to 9-4-86)	675 (277-1,747)	—	8.1 (7.3-8.9)	—	221 (10-21,100)	—
Marias/Teton Subbasin						
Marias River near Chester (8-12-64 to 8-19-68)	374 (235-486)	9.0 (2-22)	8.0 (6.8-8.9)	12.4 (9.2-15)	4.0 (1-26)	1.0 (1.0-2.0)
Middle Missouri Subbasin						
Missouri River at Virgelle (10-2-74 to 9-23-85)	276 (217-377)	9.7 (0.0-24)	8.4 (7.7-8.8)	10.6 (7.3-14.8)	36 (5-2,460)	15 (9-20)
Missouri River near Landusky (7-16-76 to 12-4-90)	314 (240-711)	—	8.4 (7.5-8.9)	9.2 (5.2-14.0)	193 (11-25,100)	14 (7-28)
Musselshell River at Mosby (10-22-74 to 11-14-90)	1,510 (421-3,778)	8.0 (0.0-26)	8.2 (7.1-8.9)	9.9 (5.7-67)	130 (13-4,880)	2.0 (1-52)
Musselshell River at Harlowton (11-5-87 to 11-13-90)	673 (501-1,641)	10.3 (0.5-23.5)	8.1 (8.0-8.5)	11.2 (7.8-12.3)	36 (16-108)	— (1-2)

a Data retrieved from U.S. Geological Survey WATSTORE Data Base by Montana State Library Natural Resource Information System; statistical analysis performed by DNRC.
b Period of record analyzed
c Median value of parameter (half the measured values are above, and half are below).
d Minimum and maximum value of parameter.
e Information available for final EIS.

dissolved solids concentrations and are slightly alkaline. The Missouri River and its tributaries from Three Forks to Belt Creek are classified with the A or B designation; most streams are classified B-1.

Municipal and irrigation return flows result in moderate impairment of the Missouri River in the vicinity of Great Falls where TDS concentrations increase, particularly during low flows. Improved municipal and industrial treatment has resulted in improved water quality in recent years. As the Missouri flows from the mountains to the plains, TDS and water temperature gradually increase.

Notable problems in the Upper Missouri Subbasin include low flows, sedimentation, elevated water temperature, acid mine drainage, and high arsenic concentrations. According to DHES (1990), Muddy Creek, a tributary to the Sun River, and Prickly Pear Creek, near Helena, were recently classified "I" because of near permanent damage to several water uses caused by past resource extraction.

Streams in the Belt Creek drainage are impaired by metals and acid mine drainage from past mining activity. Metals problems occur in the Sand Coulee area groundwater and surface water from past coal mining. Silver Creek, Corbin Creek, Virginia Creek and other tributary streams in and around the Helena Mining District have impairment from both historical and recent mining activity.

Sedimentation problems occur along Thompson Gulch; the Dearborn, Sun, and Smith rivers; Flat, Newlan, Hound, Sheep, Big Otter, Tenmile, Little Prickly Pear, Prickly Pear, Trout, Crow, and Sixteenmile creeks; and other tributaries to the Missouri River and Canyon Ferry Reservoir.

Low water resulting from reservoir regulation and irrigation withdrawals contributes to elevated summer temperatures on the Missouri, Sun, Dearborn, and Smith rivers and Sixteenmile Creek.

The Sun River drainage has sedimentation and elevated TDS problems, particularly in and below Muddy Creek. These problems, caused by irrigation, are the subject of correctional programs by farmers and the local conservation district.

Arsenic problems, as described in the Headwaters Subbasin, are recognized as being present in the Missouri main stem downstream where total recoverable arsenic concentrations range from 50 to 90 µg/L at Three Forks to 23 to 28 µg/L below Canyon Ferry Dam.

Marias/Teton Subbasin

The Marias River, Teton River ,and their tributaries support a wide variety of uses, with most streams classified B-1. The streams generally have low concentrations of dissolved solids and are slightly alkaline.

As the Marias River makes a transition to lower elevations, water quality deteriorates. Water temperatures and sediment concentrations increase, and nutrient and salt concentrations rise. Water quality deterioration in the lower Marias grows more pronounced during times when streamflows are low.

Notable water quality problems in the Marias/Teton Subbasin include sedimentation, elevated water temperature, and high salinity. The Marias River below Tiber Reservoir receives sediment from agricultural and natural erosion processes, and as a result of reservoir releases. Birch Creek, South Fork Two Medicine River, and Badger Creek have moderate sediment problems. Cut Bank Creek also is affected by sedimentation and salinity.

Freezeout Lake serves as a sink for irrigation return flows from the Greenfields Bench irrigation project (DHES 1986). Evaporation exceeds precipitation in the area, thus concentrating salts in the lake. The lake outlet is through Priest Butte Lakes to the Teton River. Periodic releases of water from the lake system are used to maintain flow levels, but these flows have deteriorated water quality in the Teton River. A water release system to reduce salinity began operation in 1984 and is working. High flows from the lake erode unstable streambed materials in the Teton River, causing high turbidity. Deep Creek also has high sedimentation during high runoff periods.

Middle Missouri Subbasin

The Missouri River and its tributaries from Belt Creek to Fort Peck Reservoir support a wide variety of uses with all streams classified B-1 to C-3.

Water quality in the Middle Missouri Subbasin varies from high quality, mountain spring flows to turbid, nutrient-rich waters with low dissolved oxygen levels.

Arsenic has been sampled in the Missouri River near Landusky and in the Musselshell River near Mosby (USGS 1987). Concentrations of 7 to 16 µg/L were found in the Missouri near Landusky. In contrast, less than 1 µg/L was found in the Musselshell near Mosby. Arsenic concentrations found in the Missouri River near Landusky are lower than those farther upstream because arsenic is being diluted by tributary inflow.

The character of the Missouri River changes between the confluence of the Marias and Teton rivers downstream to Fort Peck Reservoir. Water quality gradually deteriorates as water temperatures and sediment concentrations increase. Total suspended sediment concentrations at low flows average 80 mg/L, which is close to tolerance limits for some forms of aquatic life. Average TDS concentrations increase to 350 mg/L and during periods of critical low flow can exceed the limit of 500 mg/L for drinking water.

Notable water quality problems in the Middle Missouri Subbasin are sediment and salt accumulations caused by irrigation return flow, poor soil conservation practices, saline seep, overgrazing, and natural processes. The Missouri River from Belt Creek to Fort Peck Dam is affected by sulfates and TDS.

Alluvial gravels in the Judith River drainage near the Anderson Bridge contain TDS concentrations ranging between 500 and 750 mg/L (Aquoneering 1988). Saline seeps created by dryland agricultural practices drain into the Judith River and cause salinity problems.

Recently, timber harvests along the South Fork Judith River have intensified sedimentation. Yogo Creek has received considerable siltation from mining activity. Cottonwood and Beaver creeks have elevated water temperatures during critical low flow periods. The East Fork of Big Spring Creek has elevated water temperatures from operation of a flood control impoundment.

Water quality in the Musselshell River drainage varies considerably. In the upper tributaries, water quality is generally good. On the main-stem Musselshell River farther downstream, flows are altered by reservoir operations and intense irrigation which cause critical low flows, high water temperatures, and lowered dissolved oxygen levels. TDS concentrations at Harlowton average 500 mg/L during low flows. During high flow periods TSS levels reach 90 mg/L. Below Shawmut the Musselshell River becomes even more turbid, water temperatures are higher, and average TDS concentrations exceed 300 mg/L. Especially high sediment loads occur during water releases from Deadmans Basin Reservoir. Low flow periods reduce the sediment load but increase salt concentrations.

In the 140 miles from Deadmans Basin to Mosby the water quality in the Musselshell becomes even further degraded. TDS concentrations near Mosby can reach 3,700 mg/L while TSS levels during low flow periods range between 100 and 1,400 mg/L. Stream temperatures reach 77 degrees Fahrenheit and dissolved oxygen levels drop below the 5 mg/L necessary to sustain aquatic life. Reservoir storage, degraded irrigation return flows, drought, and consumptive uses combine to render the lower river reaches unacceptable for most beneficial uses. Flows in Flatwillow Creek become low during times of peak irrigation, while at the same time return flows contribute pollutants and sediment into the stream.

The Montana Bureau of Mines and Geology has studied the quality of water in coal mines near the Musselshell River in the vicinity of Roundup (Wheaton and Van Voast 1989; Wheaton 1990). Appendix E shows the major dissolved constituents found in the mine water samples. The water chemistry varies between mines, with the Jeffrey Mine having the lowest level of dissolved solids and the Roundup #3, Prescott, and Republic #2 mines having very high dissolved solid loads. Comparing these recent analyses with older analyses shows that the water quality of the mines has changed over time, and it is likely that their chemistry is still evolving. Dissolved solids and sulfate levels have dramatically increased in the Republic #1, Republic #2, and Roundup #3 mines, and presumably the Prescott mine. Concentrations of other constituents and sodium absorption ratios have also increased.

Water quality in the Jeffrey Mine is similar to that of the surrounding aquifer. When compared to the Musselshell River, dissolved solid and sulfate concentrations in the Jeffrey Mine are higher than those in the river at high flows but lower than the river concentrations at low flows. The present water quality of the Republic #2, Prescott, and Roundup #3 mines is poorer than that of the Musselshell River at all flow levels and the Jeffrey Mine.

CLIMATE, SOILS, AND STREAM CHANNEL FORM

CLIMATE

Climate in the Missouri Basin is diverse, primarily because of the great variation in altitude and location of mountain ranges. Average annual precipitation in the basin is shown on Map 4-3. The length of the growing season, or the length of time plants are using water, is indicated by the number of frost-free days on Map 4-4.

SOILS

Headwaters Subbasin

Irrigation projects proposed by conservation districts in the Headwaters Subbasin comprise approximately 23,000 acres of cropland and rangeland. Names of major soils series are presented in Appendix F. The soils are generally well drained, sandy, gravelly, and cobbly loams and silt loams high in calcium carbonate and low in organic matter. Soils on upland terraces, fans, and benchlands are highly susceptible to wind erosion when fallow because of their exposed landscape position and sandy loam textures. Shallow water tables restrict drainage within portions of the study area. Poor drainage is associated with elevated salt levels.

Upper Missouri Subbasin

Approximately 27,000 acres of soils may be affected by water reservations in the Upper Missouri Subbasin. Most of these projects are located on three distinct landforms: upland alluvial benches, sedimentary uplands, and floodplains.

Soils on upland alluvial benches are loams, silt loams, and gravelly loams. They are low in organic matter, high in calcium carbonate, and highly susceptible to wind erosion. The gravelly phases of these soils hold less than three inches of water available to plants and have rapid permeability. A study of groundwater in the Townsend Valley (Lorenz and McMurtrey 1956) identified 8,500 acres of waterlogged soil in and adjacent to the Missouri River floodplain. According to the study, several thousand acres became waterlogged after 25 years of irrigation on adjacent alluvial benchlands.

Soils developed in marine sediments on stable upland benches have surface layers rich in organic material, have subsoil layers of accumulated clay, and can hold large amounts of water. The crop fallow system of dryland farming on upland benches underlain by marine shales has led to excess soil moisture, deep percolation of soil water, and saline seep development where percolating groundwater discharges to the surface.

The floodplain soils have loam, clay loam, and sandy loam surface textures with stratified sands and gravels as subsoils. Sandy loam surface soils on floodplains are susceptible to wind erosion when fallow. Excessive sodium in some clay loam floodplain soils restricts water infiltration.

Marias/Teton Subbasin

Approximately 68,000 acres of irrigation development are proposed by eight conservation districts in the Marias/Teton Subbasin. The largest portion of this area lies on the plain formed by glaciers north of the Missouri River. These soils are typically well drained, have low permeability, and can hold large amounts of water accessible to plants. They have been highly productive under a winter wheat fallow crop rotation system. In parts of Chouteau County, glacial soils are extensively covered by fine sands and sandy loams deposited by glacial meltwater or wind. These materials have higher permeability and will hold less water than clay loam soils developed from glacial till.

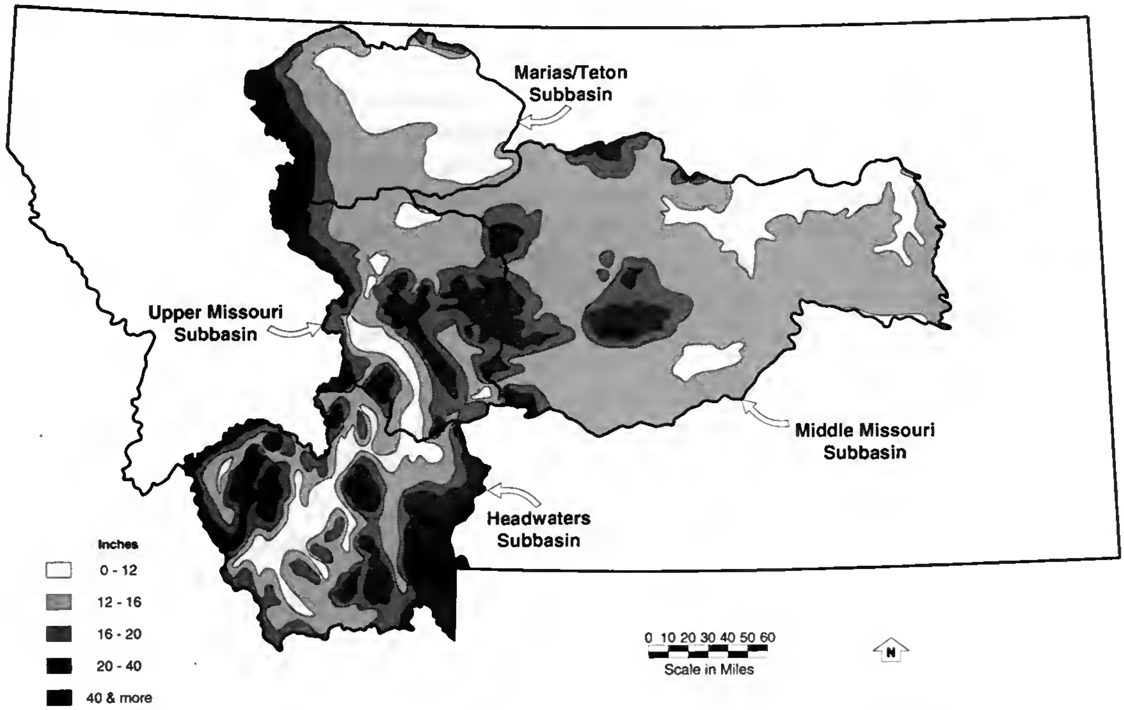
A second extensive group of soils in the Marias/Teton Subbasin was developed from shale on upland plains. The high salt content of the shale has caused saline seep development in portions of the subbasin where crop fallow dryland farming allows deep percolation of excess soil moisture.

The Marias/Teton Subbasin also contains projects on floodplains, where soils are similar to the loams and sandy loams listed for the Headwaters and Upper Missouri subbasins. Shallow soils developed from sandstone and shale occur on steep terrain between the river floodplains and adjacent uplands. Slopes are from 25 to 45 percent.

Middle Missouri Subbasin

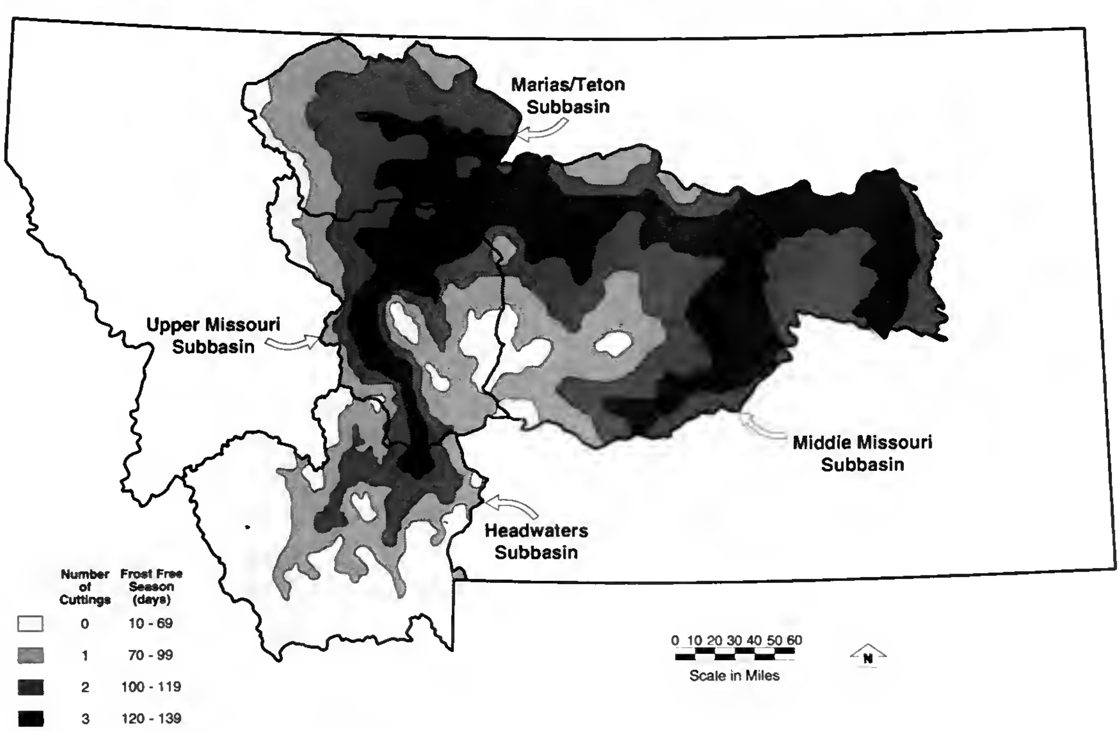
The Fergus County, Judith Basin, and Valley County conservation districts are proposing approximately 34,000 acres of irrigation in the Middle Missouri Subbasin. Most of this acreage is in Valley County's project on the Glasgow Bench between Fort Peck Reservoir and the Milk River. The soils have developed in glacial till and fine-textured meltwater alluvium.

Map 4-3. Average annual precipitation in the Missouri River basin



Based on period 1953-1967.
Source: USDA Soil Conservation Service, Montana Water Resources Board, National Weather Service, and Montana Crop and Livestock Reporting Service, 1986.

Map 4-4. Expected number of alfalfa cuttings per year based on length of frost free season



Source: Plant and Soil Science Department, Montana State University, Bozeman, Montana, 1990.

Most of the proposed projects in Judith Basin and Fergus counties are on upland terraces and on the floodplains of the Missouri and Judith River tributaries. The upland soils have gravelly loam textures and are high in calcium carbonate. Their exposed position on the landscape and high lime content make them susceptible to wind erosion. The floodplain soils have generally finer textures than those on high terraces and are less susceptible to wind and water erosion. Finer soils have larger percentages of clay that form stable, erosion resistant aggregates.

STREAM CHANNEL FORM

Besides conveying water, streams transport sediment. Sediments can move down a stream as suspended particles or by rolling, sliding and bouncing down the stream bottom. The physical characteristics of the watershed and especially the types of sediments available for transport will determine the characteristics of the stream channel.

Stream channels in the Missouri basin have a variety of physical traits, with some being steep and narrow, others broad and with low gradient. Others have any number of variants of these characteristics. However, most of the streams in the Missouri basin, whether at high or low elevations, follow a meandering pattern with water flowing through alternating pools and riffles.

The forms of stream channels in the Missouri basin are important to the growth of aquatic plants, insects, and other invertebrates that provide forage for fish and wildlife. Such life also is supported by other features of the stream channels, such as boulders that lower water velocity and streamside trees that provide shade. Given the importance of stream channel form to aquatic life and streamside habitat, much attention has recently been given to determining the streamflows necessary to maintain channel form.

It is sometimes assumed that the "bankfull discharge" is primarily responsible for forming and preserving the stream channel. This is because streams are most effective at transporting sediments at these flows, and because bankfull discharge occurs frequently enough to be dominant in channel formation—bankfull discharge generally occurs every one or two years. However, research has shown that channel characteristics do not always relate to bankfull discharge (Knighton 1984). This suggests that occasional bankfull flows in combination with other flows throughout the year are important in forming and preserving the stream channel.

Human activities have altered channel form with subsequent effects to aquatic life and riparian habitat. In some cases, diverting water from streams has resulted in the deposition of sediments, growth of vegetation, and a subsequent reduction in stream-channel area (Wesche et al. 1988). On the other hand, human-caused increases in streamflow can cause scouring of the channel. Damming rivers can also affect stream channel characteristics downstream (Knighton 1984). Some streams have been affected by the use of rip-rap and other measures intended to stabilize stream channels.

LAND USE

The Missouri River drains 34.5 million acres above Fort Peck Dam (Missouri River Basin Commission 1981) (Map 4-5). Even though land use has changed considerably over the last century, the amount of land developed for most uses has changed little since the 1950s (Frey and Hexem 1985; Fedkiw 1989). In Montana, the most productive land was settled first. Intensive uses such as towns, residences, transportation routes, and commercial areas were developed in strategic locations near waterways. Unproductive land was usually left undeveloped (Alig et al. 1990; Wall 1981).

TRANSPORTATION

Transportation corridors link the major cities in the basin. The Burlington Northern rail line crosses the basin from Glasgow to Marias Pass. The Montana Rail Link passes through Bozeman, Butte, and Helena. The Union Pacific line enters Montana at Monida and extends to Butte. Interstate Highway 90 crosses the basin east/west, and Interstate 15 runs north and south from the Canadian line north of Shelby to the Continental Divide at Monida. Federal, state, and county roads link all cities and towns.

POPULATION

The population of the 26 Missouri basin counties most affected has increased 6 percent over the past 30 years, from 317,000 in 1960 to 335,000 in 1990 (Bureau of Census 1990) and is expected to be stable or decline slightly in the next 10 years (Albert et al. 1989). The population increase over the past 30

Map 4-5. Designated lands in the Missouri basin study area

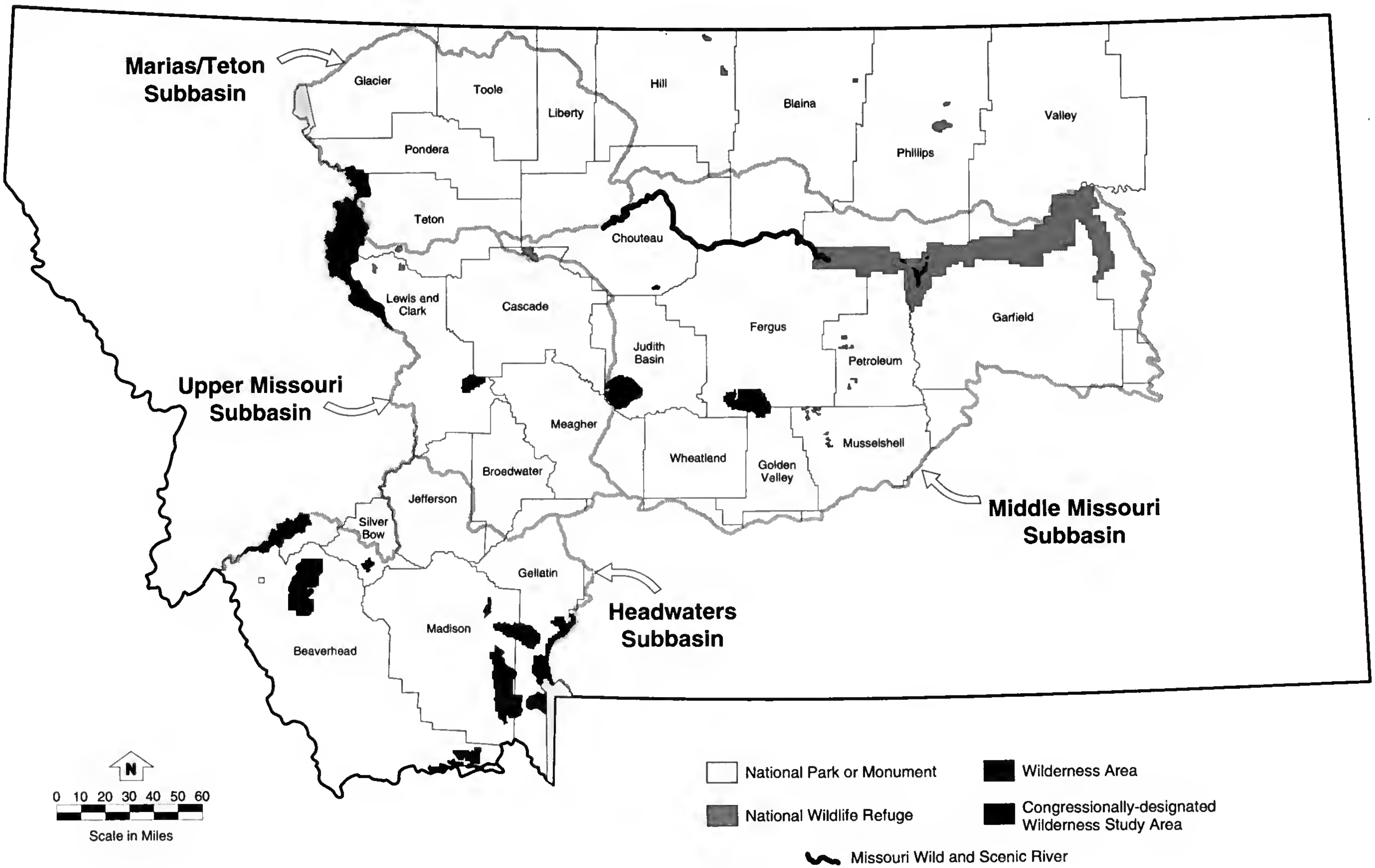
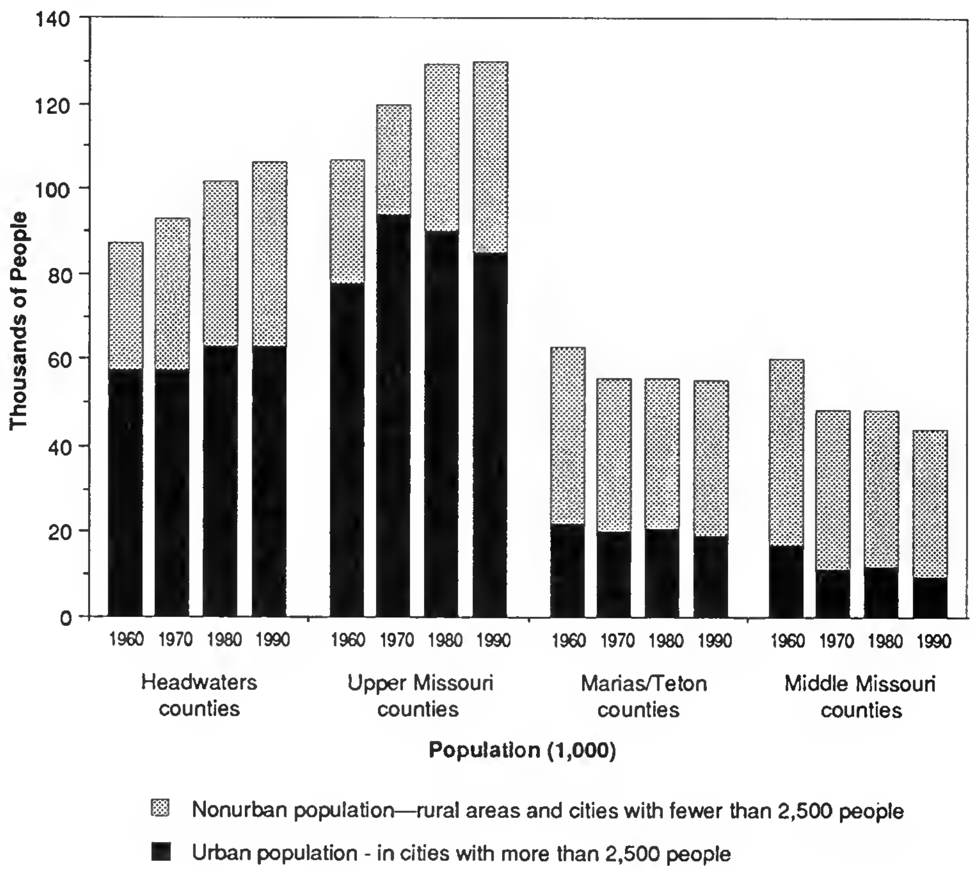


Figure 4-6. Population trends in Missouri basin counties



years is substantially less than the U.S. nationwide increase of 37 percent and the Montana increase of 18 percent during the same period. Eighteen of the 26 counties in the Missouri basin lost population between 1960 and 1990.

However, population trends vary widely among the four subbasins. The Headwaters Subbasin grew by 22 percent (Figure 4-6). The rapid growth in Gallatin County more than offset population declines in Silver Bow County. About half of the population increase in Gallatin County was in Bozeman and Belgrade, with the remainder in rural Gallatin Valley subdivisions. Most of the Silver Bow County population loss was from the Butte area, which receives much of its water from the Big Hole River. The Upper Missouri Subbasin population increased by 21 percent. Virtually all of this growth was in rural areas surrounding Helena. The Marias/Teton Subbasin population declined 13 percent between 1960 and 1990. Much of the population loss was from rural areas and towns with fewer than 2,500 people. Over the same 30-year period, the Middle Missouri Subbasin counties had the greatest population decline, with a 28 percent loss from the 1960 population of 60,293 to 43,860.

The largest communities in counties affected by reservations are Great Falls (population 55,097), Butte/Silver Bow (population 33,336), Helena (population 24,596), and Bozeman (population 22,660). Smaller cities with 2,500 to 20,000 people include Havre, Lewistown, Dillon, Belgrade, Glasgow, Cut Bank, Shelby, and Conrad. All of these cities depend upon a river or stream for their public water supply. Rural subdivisions and residences have developed along highways and rivers, particularly in the Gallatin and Missouri valleys.

Land Use Planning

The types and extent of land use planning vary widely among subbasins and jurisdictions. Federal plans include National Forest Land and Resource

Management Plans (Forest Plans), BLM's Resource Area Management Plans (RMPs), and USFWS's Refuge Management Plans. Similarly, statehood grant land is classed into other use categories that specify the predominant management emphasis, such as timber, grazing, or agriculture. Currently, 17 of the 26 basin counties most affected by reservations have adopted a comprehensive county land use plan (Montana Department of Commerce 1989). An additional 13 cities have comprehensive city plans that can include provisions for influencing land uses up to 4 $^{1}/_{2}$ miles from the city limits. All three Indian reservations in the Missouri and Milk River basins (Blackfeet, Fort Belknap, and Rocky Boys) have adopted some type of comprehensive reservation land use plan within the past 7 years.

Other areas are managed for specific designated uses. Legislatively designated areas include national parks and monuments (Big Hole Battlefield, Glacier National Park, and Yellowstone National Park); national wildlife refuges (Red Rock, Benton Lake, Willow Creek, Pishkun, Charles M. Russell, UL Bend, Lake Mason, and War Horse); wilderness areas (Red Rock, Anaconda-Pintlar, Lee Metcalf, Gates of the Mountains, Scapegoat, Bob Marshall, and UL Bend); congressionally-designated wilderness study areas (Centennial Mountains, West Pioneers, Humbug Spires, Gallatin Divide-Hyalite, Square Butte, Middle Fork Judith, and Big Snowy Mountains); and a wild and scenic river (Missouri Wild and Scenic River—Fort Benton to Fred Robinson Bridge) (see Map 4-5).

Cropland Programs

Four major, long-term government cropland programs have affected land use patterns in the drainage. The first of these was the Agricultural Adjustment Program in the 1930s, followed by the Pick-Sloan Act in the 1940's, the Soil Bank in the 1950s, and the Conservation Reserve Program (CRP) in the 1980s (Newman 1988). The Agricultural Adjustment, Soil Bank, and CRP programs retired excess cropland, while Pick-Sloan sought to provide low-cost irrigation water. Virtually all of the cropland retired under CRP has been revegetated (Newman 1988).

One-half of Montana's cropland (8 million acres) is eligible for retirement payments under CRP (Newman 1988). In mid-1990, approximately 2.7 million acres (16 percent of Montana's cropland) had been contracted for long-term retirement from production under CRP (Patrick 1990). Four basin counties (Garfield, Golden Valley, Musselshell, and Phillips) had reached the program's limit of 25 percent of county cropland in CRP.

Wild and Scenic Rivers

At present, the Upper Missouri Wild and Scenic River between Fort Benton and the Fred Robinson Bridge is the only designated national wild and scenic river in the Missouri basin. Under the Wild and Scenic Rivers Act, a river is classified as wild, scenic, or recreational, depending on the values for which it was designated, including scenic, recreational, geologic, fish and wildlife, historic, cultural, or other values. The federal government generally is prohibited from taking actions that would adversely affect the values that qualify the river for inclusion in the system (Utter and Schultz 1976). However, upstream and downstream water developments are permitted if they do not deprive the designated river segment of the water needed to maintain its scenic, recreational, and fish and wildlife values.

The Wild and Scenic Rivers Act expressly asserts the existence of a federal reserved water right for an amount necessary to preserve and protect the values for which the river was designated. The 1976 legislation designating the 149-mile section of the Missouri River from Fort Benton to the Fred Robinson bridge as a part of the Wild and Scenic Rivers System specifically provided that, to the extent consistent with the Wild and Scenic Rivers Act, the administering agency (Bureau of Land Management) may permit pumping facilities and pipelines necessary for future agricultural uses outside the river corridor (Public Law 94-486). BLM has identified minimum instream flows necessary to protect fish and aquatic habitat, goose nesting, recreation, and channel stability (see Table 4-16).

The U.S. Forest Service (USFS), through its planning process, has identified 22 stream segments eligible for wild and scenic designation on national forest land in the Missouri basin, including 11 segments in the Headwaters Subbasin, 8 in the Upper Missouri Subbasin, 2 in the Marias/Teton Subbasin, and 1 in the Middle Missouri Subbasin (Table 4-20). At present, these eligible river segments are managed to protect their identified outstanding resource values. Within the next 10 years, the Forest Service will study all 22 segments to determine their future management.

Table 4-20. Missouri River basin wild and scenic rivers and eligible rivers

River	Drainage Area	General Area	Segment	Length of Segment (miles)	Classification	Outstanding Features
CLASSIFIED WILD AND SCENIC RIVERS						
Missouri River	Missouri River above Fort Peck	East of Fort Benton	Fort Benton to Fred Robinson Bridge	149	63.5 miles wild 25.5 miles scenic 60.0 miles recreational	
MISSOURI RIVER BASIN STREAM SEGMENTS ELIGIBLE FOR WILD AND SCENIC RIVER CLASSIFICATION[a]						
Headwaters Subbasin						
Deadman Creek	Beaverhead	South of Dillon	Headwaters to FS boundary	10.2	Wild	Recreation, wildlife, cultural
Browns Canyon	Beaverhead	West of Dillon	Headwaters to FS boundary	4.3	Wild	Fish
Wise River	Big Hole	Southwest of Butte	Jacobsen/Mono Creeks to Pattengail	13.6	Recreational	Scenery, recreation
Canyon Creek	Big Hole	Southwest of Butte	Headwaters of Lion Creek to $3^1/_2$ miles east of Canada Creek Station	6.4 4.6 11.0	Recreational Wild	Scenery, recreation, cultural, wildlife
Warm Springs Creek	Ruby	Southwest of Ennis	South of Romy Lake to below Middle Fork Warm Springs	6.1	Recreational	Geologic
Mill Creek	Ruby	West of Twin Bridges	Upper Branham Lake to FS boundary	7.0	Recreational	Cultural, scenery
West Fork Madison	Madison	West of West Yellowstone	Headwaters to Madison River	8.2 7.4 6.5 22.1	Wild Scenic Recreational	Fish, recreation Fish, recreation
Madison River	Madison	Northwest of West Yellowstone	Hebgen Dam to FS boundary	8.0	Recreational	Fish, scenery, geologic, recreation
Elk River	Madison	West of West Yellowstone	Headwaters to West Fork Madison	9.2 5.2 14.4	Wild Scenic	Fish, recreation Fish, recreation
South Willow Creek	Jefferson	SW of Three Forks	Granite Lake to FS boundary	7.5	Recreational	Fish
Gallatin River	Gallatin	South of Bozeman	Yellowstone NP to FS boundary	39.0	Recreational	Fish, scenery, recreation

River	Drainage Area	General Area	Segment	Length of Segment (miles)	Classification	Outstanding Features[d]
Upper Missouri Subbasin						
Beaver Creek	Missouri-above Holter Dam	Northwest of Helena	Nelson to Missouri River	4.5	Recreational	Fish
Missouri River	Missouri-above Holter Dam	Northwest of Helena	Hauser Dam to Cochrans Gulch	2.5	Scenic	Fish, geologic, wildlife, recreation, natural
Smith River	Smith	North of White Sulphur Springs	Tenderfoot Creek to Deep Creek	11.8[b]	Scenic	Scenery, recreation, geologic, fish, wildlife
Tenderfoot Creek	Smith	North of White Sulphur Springs	Falls to Smith River	4.6[c]	Scenic	Fish
Dearborn River	Dearborn	Scapegoat Wilderness	Headwaters to FS boundary	18.1	Wild	Scenery
South Fork Sun River	Sun	West of Augusta	Headwaters to confluence	25.5	Wild	Recreation
North Fork Sun River	Sun	Northwest of Augusta	Headwaters to confluence	25.4 1.3 26.7	Wild Recreational	Recreation Recreation
Green Fork of Straight Creek	Sun	West of Augusta	Headwaters to Straight Creek	4.5	Wild	Scenery, geologic
Marias Subbasin						
North Fork Birch Creek	Two Medicine	West of Dupuyer	Headwaters to Swift Reservoir	6.6	Wild	Scenery, geologic
North Badger Creek	Two Medicine	South of East Glacier	Pool Creek to falls	7.3	Scenic	Fish
Middle Missouri Subbasin						
Middle Fork Judith	Judith	South of Stanford	Arch Coulee Junction to Forest Service boundary	4.8	Recreational	Cultural
Totals: 22 stream segments				260.1	10 wild river segments 6 scenic river segments 11 recreational segments	

a Missouri River drainage above Fort Peck dam, identified by U.S. Forest Service in Forest Plans and Amendments. Summary from 8/24/89 printout and river eligibility summary reports.
b Total distance between upper and lower boundary is 23 miles, but the eligibility classification applies to only 11.8 miles of National Forest land along the river.
c Total length is 8.6 miles, but eligibility classification includes only 4.6 miles of National Forest land.
d Features as defined in the Wild and Scenic Rivers Act of 1968

Missouri River Basin Land Uses

The Missouri basin above Fort Peck Dam includes 45.5 million acres (Table 4-21). Private land makes up about two-thirds of the drainage area, ranging from 79 percent in the Marias/Teton Subbasin to 45 percent in the Headwaters Subbasin. State land is consistently about 6 percent of each subbasin area, reflecting the state's selection of about two sections per township. State land is managed primarily to generate revenue for funding the state school system. Federal land makes up about 29 percent of the total drainage, ranging from 49 percent in the Headwaters Subbasin to 14 percent in the Marias/Teton Subbasin.

Missouri basin land uses have followed national and regional trends. Approximately 25 percent of the drainage is in forests, parks, and wildlife habitat areas, with the bulk of this land concentrated upstream from Great Falls (Table 4-22). Most of the drainage is in rangeland and grassland pasture (57 percent), with the majority of the rangeland located

Table 4-21. Missouri basin land ownership

Acres of Land	Headwaters Subbasin[a]	Upper Missouri Subbasin[a]	Marias/Teton Subbasin[a]	Middle Missouri Subbasin[a,b]	Missouri basin above Fort Peck Dam Total[a]	Percent
Private	4,014,146	3,955,362	8,674,477	12,856,058	29,500,943	65%
State	523,791	326,591	779,681	1,180,938	2,810,001	6%
Federal	4,402,963	1,947,167	1,553,202	5,323,964	13,227,196	29%
Total Acreage	8,940,800	6,229,120	11,007,363	19,368,966	45,546,249	100%

Source: Montana Department of Commerce 1985
[a] Includes all lands within the 26 counties identified in Map 4-5.
[b] Also includes counties in the Milk River basin.

Table 4-22. Missouri basin land use

Land Use Category	Subbasins: Headwaters Thousand Acres	Headwaters % of Area	Upper Missouri Thousand Acres	Upper Missouri % of Area	Marias/Teton Thousand Acres	Marias/Teton % of Area	Middle Missouri Thousand Acres	Middle Missouri % of Area	Missouri Drainage Total Thousand Acres	Missouri Drainage Total % of Area
Forests, parks & wildlife[a]	4,193	47%	2,884	46%	1,022	9%	3,502	18%	11,601	25%
Grassland pasture & rangeland[b]	3,829	43%	2,554	41%	6,601	60%	13,101	68%	26,094	57%
Cropland total	562	6%	542	9%	2,944	27	1,992	10%	6,031	13%
Dryland[c]	*125	22%	*371	*68%	*2,477	*84%	*1,636	*82%	*4,609	*76%
Irrigated[d]	*384	*68%	*120	*22%	*189	* 6%	*169	*8%	*853	*14%
Idle and pasture[e]	*53	*9%	*51	*9%	*278	*10%	*187	*9%	*569	*9%
Developed residential areas[b]	77	0.9%	122	2%	29	0.3%	45	0.2%	273	0.6%
	*65		*113		*13		*17		*208	
	*13		*9		*16		*28		*65	
Special uses and miscellaneous[f]	280	3%	127	2%	411	4%	729	4%	1,547	3%
Total	8,941		6,229		11,007		19,369		45,546	

* These acres are subcategories of the above more inclusive land-use category.
[a] Estimated from Department of Commerce 1985. Includes forests, parks, wilderness areas, and areas administered by state and federal wildlife agencies
[b] Estimated from Department of Commerce 1985.
[c] Includes dryland harvested cropland and failed cropland (both dryland and irrigated).
[d] Includes irrigated acres that were both harvested and irrigated rather than acres that could be irrigated or that were irrigated but not harvested.
[e] The idle and pasture cropland acreages are estimated from statewide averages and do not include cropland enrolled in CRP.
[f] Estimated from statewide averages. Includes defense and industrial areas, mines, highways and transportation areas, marshes, floodplains, bad lands, and bare rock.
Source: Department of Commerce 1985; Montana Crop & Livestock Reporting Service 1989; Frey and Hexem 1985

downstream from Great Falls. Less than 1 percent of the basin is urban or residential. Three percent of the basin's land is in other use categories, such as transportation corridors, swamps, small lakes, and bare rock.

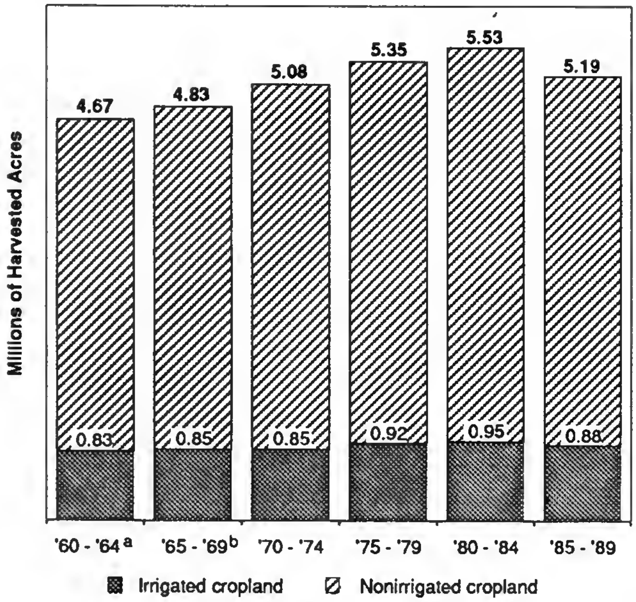
Land used for crops includes dryland crops (10 percent of drainage), harvested irrigated cropland (2 percent of drainage), and idle pasture/cropland (1 percent of drainage), which together total about 13 percent of the drainage. Almost all of the dryland crop acres are located below Great Falls, while the majority of the irrigated acres are located above Great Falls (Table 4-22 and Map 4-6). Total harvested acreage increased 18 percent between the early 1960s and the early 1980s and decreased 6 percent in the late 1980s (Figure 4-7). Irrigated acreages of these crops have remained relatively constant.

Over half the irrigation in the Missouri drainage is concentrated in five counties—Beaverhead, Madison, and Gallatin in the Headwaters Subbasin and Pondera and Teton in the Marias/Teton Subbasin (Map 4-6). Most of the irrigated land is used to grow alfalfa. Missouri basin alfalfa yields have increased from 2.5 tons per acre in the mid-1960s to about 3.0 in the 1980s (Montana Crop and Livestock Reporting Service 1964 through 1989) because of improved genetic stock, and more efficient crop, water, and fertilizer management (Figure 4-8).

Harvested cropland figures throughout this EIS underestimate total irrigated land because they do not take into account unharvested land, subirrigated land, and land receiving occasional water spreading. Furthermore, harvested croplands are average values, whereas total irrigated acres are the maximum ever irrigated. Irrigated cropland information from the Montana Agricultural Statistics Service (1964 through 1989) is presented to show relative trends over time (Figure 4-7).

Irrigated alfalfa acreage in the basin above Fort Peck has averaged about 135,000 harvest acres over the past 20 years. Even though irrigated acreage did not increase, irrigated alfalfa production grew 24 percent over the past 25 years, due primarily to the increased crop yields (Figure 4-8).

Figure 4-7. Annual harvested acres of alfalfa hay, other hay, wheat, oats, and barley in the Missouri River basin above Fort Peck Dam

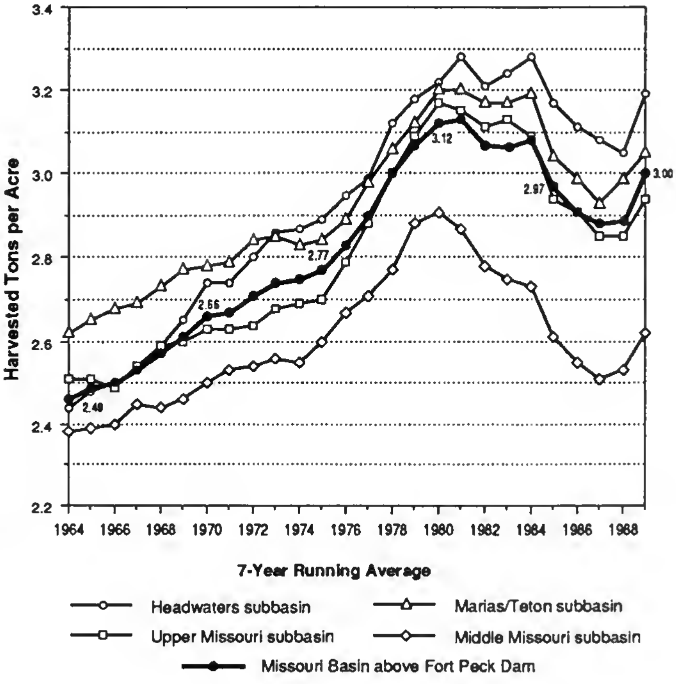


Total of 26 counties in the Missouri basin above Fort Peck Dam

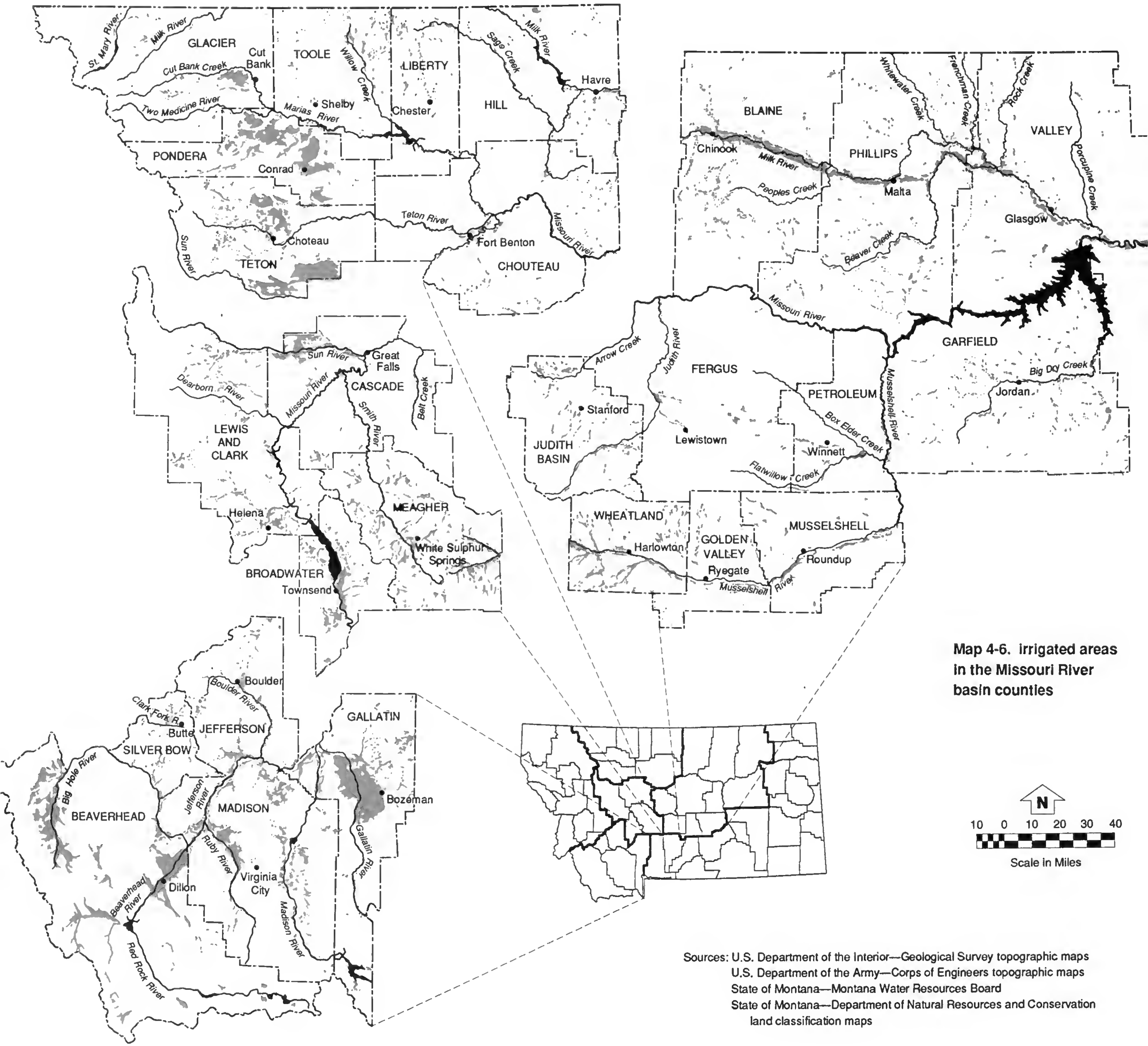
a Alfalfa and other hay acreages estimated from statewide data
b Other hay acreages estimated from statewide data

Source: Montana Crop and Livestock Reporting Service 1960 through 1989

Figure 4-8. Irrigated alfalfa yield trends in the Missouri River basin above Fort Peck Dam



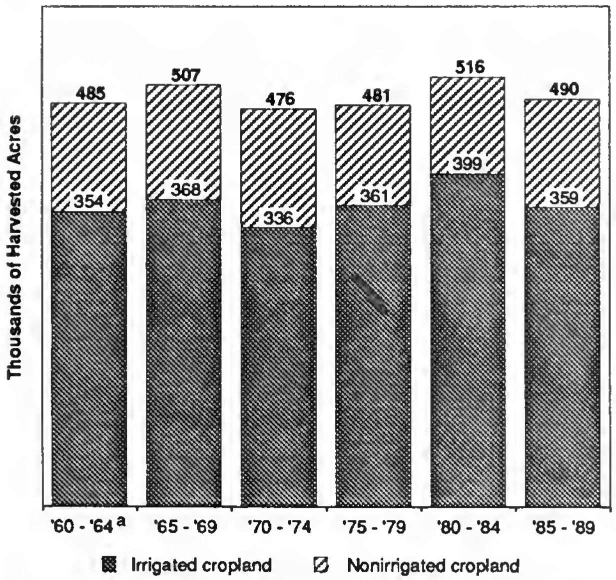
Source: Montana Crop and Livestock Reporting Service 1964 through 1989



Map 4-6. Irrigated areas in the Missouri River basin counties

Sources: U.S. Department of the Interior—Geological Survey topographic maps
U.S. Department of the Army—Corps of Engineers topographic maps
State of Montana—Montana Water Resources Board
State of Montana—Department of Natural Resources and Conservation land classification maps

Figure 4-9. Annual harvested acres of alfalfa hay, other hay, wheat, oats, and barley in the Headwaters Subbasin

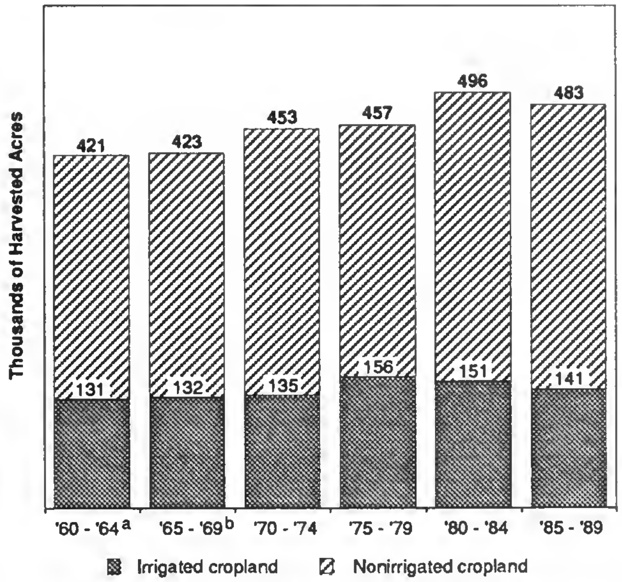


Beaverhead, Gallatin, Jefferson, Madison, and Silver Bow counties

a Alfalfa and other hay acreages estimated from statewide data

Source: Montana Crop and Livestock Reporting Service 1960 through 1989

Figure 4-10. Annual harvested acres of alfalfa hay, other hay, wheat, oats, and barley in the Upper Missouri Subbasin



Broadwater, Cascade, Lewis and Clark, and Meagher counties

a Alfalfa and other hay acreages estimated from statewide data
b Other hay acreages estimated from statewide data

Source: Montana Crop and Livestock Reporting Service 1960 through 1989

HEADWATERS SUBBASIN

Land in the Headwaters Subbasin is used in the following manner: 47 percent for forests, parks, and wildlife management and areas, 43 percent for pasture and rangelands, and 6 percent for cropland. Of the cropland, 22 percent is dry cropland, 68 percent is irrigated, and 9 percent is in pasture or idle (Table 4-22). Harvested cropland in this subbasin has averaged around 490,000 acres, with long-term fluctuations of up to 15 percent (Figure 4-9). Irrigated cropland has averaged about 360,000 harvested acres, which is 68 percent of the total harvested cropland in the subbasin.

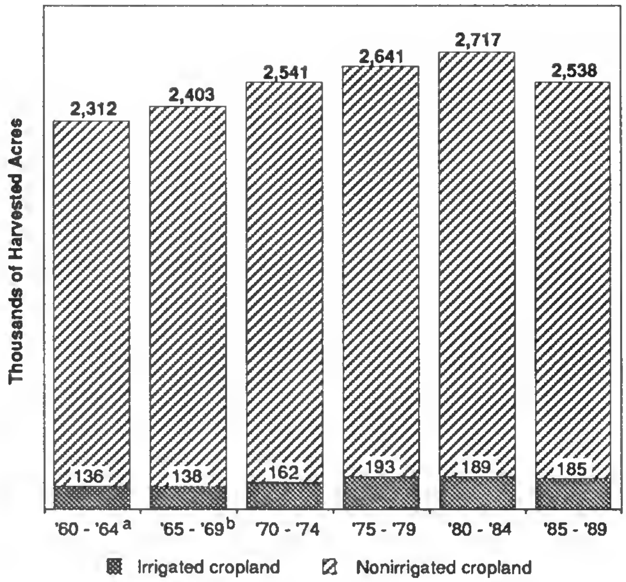
UPPER MISSOURI SUBBASIN

Land in the Upper Missouri Subbasin is used in the following manner: 46 percent for forests, parks, and wildlife management areas; 41 percent for pasture and rangeland; and 9 percent for cropland. Of the cropland, 68 percent is dry land, 22 percent is irrigated, and 9 percent is pasture or idle (Table 4-22). Harvested cropland in this four-county area increased by 15 percent from the late 1960s to the late 1980s to an average of 490,000 acres (Figure 4-10). Irrigated harvested cropland increased by 19 percent between the early 1960s and the late 1970s, then decreased by 10 percent in the late 1980s. Twenty-two percent of the subbasin harvested cropland is irrigated. Irrigated alfalfa acreage declined 8 percent from the late 1960s to the present. However, total alfalfa production increased by 7 percent over the same period as a result of alfalfa yields increasing 13 percent (Figure 4-8).

MARIAS/TETON SUBBASIN

Land in the Marias/Teton Subbasin is used as follows: 60 percent for pasture and rangeland; 27 percent for cropland; and 9 percent for forest, parks, and wildlife management areas. Of the cropland, 84 percent is dryland, 10 percent is pasture or idle, and 6 percent is irrigated (Table 4-22). Harvested cropland has remained around 2.6 million acres since the early 1970s, a 10 percent increase from the mid-1960s (Figure 4-11). A recent trend shows slight declines in cropland from the peak in the early 1980s. Irrigated cropland acreage has been stable since the mid-1970s (Figure 4-11).

Figure 4-11. Annual harvested acres of alfalfa hay, other hay, wheat, oats, and barley in the Marias/Teton Subbasin

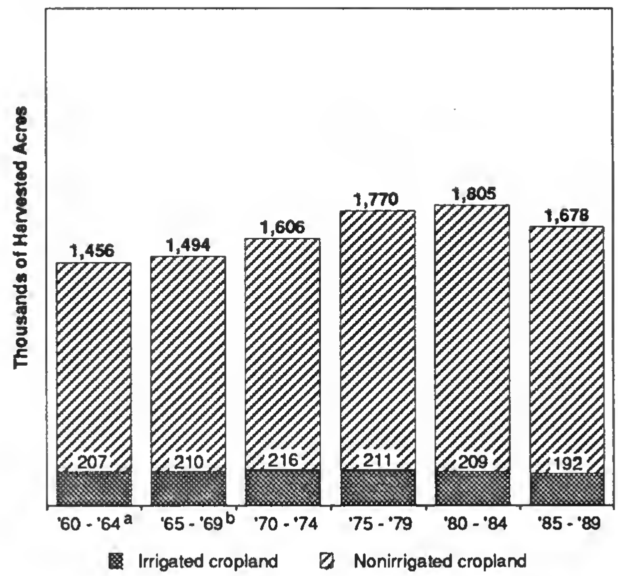


Chouteau, Glacier, Hill, Liberty, Pondera, Teton, and Toole counties

a Alfalfa and other hay acreages estimated from statewide data
b Other hay acreages estimated from statewide data

Source: Montana Crop and Livestock Reporting Service 1960 through 1989

Figure 4-12. Annual harvested acres of alfalfa hay, other hay, wheat, oats, and barley in the Middle Missouri Subbasin



Blaine, Fergus, Garfield, Golden Valley, Judith Basin, Musselshell, Petroleum, Phillips, Valley, and Wheatland counties

a Alfalfa and other hay acreages estimated from statewide data
b Other hay acreages estimated from statewide data

Source: Montana Crop and Livestock Reporting Service 1960 through 1989

Irrigated alfalfa acreage decreased by 26 percent between the early 1970s and the present, while total alfalfa production slid only 19 percent because alfalfa yields increased 12 percent (Figure 4-8).

Middle Missouri Subbasin

Land in the Middle Missouri Subbasin is used in the following manner: 68 percent for rangeland and pasture; 18 percent for forests, parks, and wildlife management areas; and 10 percent for cropland. Of the cropland, 82 percent is dryland, 9 percent is pasture or idle, and 8 percent is irrigated. These figures include lands in the Milk River drainage (Map 4-6). Harvested cropland has averaged 1.7 million acres since the early 1970s, a 15 percent increase over the 1960s (Figure 4-12). Recent trends show a slight decline in harvested acreages during the 1980s. Irrigated cropland acreage also has declined slightly since the early 1970s (Figure 4-12).

Irrigated alfalfa acreage has fluctuated around 112,000 acres since the late 1960s, while total production increased by 23 percent. Much of this increase can be attributed to productivity which grew by 17 percent (Figure 4-8).

FISHERIES AND AQUATIC HABITAT

Streams and rivers in the Missouri River basin support a diverse fish population. Of the 80 species of fish found in Montana, about 55 are found in lakes and streams of the Missouri River basin above Fort Peck Dam. Between Morony Dam near Great Falls and Fort Peck Reservoir, the river makes a transition from a cold water fishery to a warm water fishery. The warm water fishery of the lower river contains the greatest diversity of fish with 39 species. In contrast, headwater tributaries often support only two to four fish species.

Information presented in the following sections comes primarily from the Rivers Study Fisheries Database located at the Montana Natural Resources Information System (MNRIS) in the Montana State Library. Fisheries value class ratings, species

composition, and relative abundance of fish were obtained from this source. DFWP's reservation application (DFWP 1989) was used to determine habitat conditions and additional information on species composition. Other information sources are cited in the text.

Species of Special Concern

The Montana Natural Heritage Program (MNHP) inventories fish species that are rare, threatened, endangered, or in need of further study to determine their status. Table 4-23 lists the fish species that MNHP has identified as species of special concern in the Missouri River basin above Fort Peck Dam (DFWP 1989). Designation of special concern does not legally protect these fish, but does indicate their rarity.

Threatened and Endangered Species

Under the authority of the Endangered Species Act, the U.S. Fish and Wildlife Service (USFWS) listed the pallid sturgeon as an endangered species, effective October 9, 1990. USFWS also is considering listing the paddlefish as a threatened species, at least in part of its range. Both these fish are found in the Missouri River downstream from Virgelle and are described below.

Regulations implementing the Endangered Species Act mandate that a decision to list a species is based solely on scientific information "without reference to possible economic or other impact of such determination." The act prohibits agencies and individuals from actions harmful to an endangered species. Prohibited activities include actions that may kill or injure individuals of a listed species by altering or degrading habitat or by impairing patterns of feeding or breeding.

USFWS will prepare a recovery plan for pallid sturgeon but it is not expected until late 1991 (Drier 1990). The recovery plan will contain recommendations for federal and state agencies to assist in the recovery of the pallid sturgeon.

When a recovery plan is implemented, all federal agencies must use their authority to carry it out. Federal agencies must consult with USFWS to ensure that any action they authorize, fund, or carry out is not likely to harm an endangered species or designated critical habitat. Such actions could include changing dam operations, issuing permits that would allow an irrigation project to proceed,

Table 4-23. Fish species of special concern in the Missouri River Basin above Fort Peck Dam.

Species	MNHP State Rank[a]	MNHP Global Rank[b]	USFWS Status[c]
Pallid sturgeon	S1	G1	C1
Paddlefish	S2	G4	C3
Montana arctic grayling	S1	G5	C2
Westslope cutthroat trout	S3	G5	—
Sturgeon chub	S3	G3	C2
Sickelfin chub	S1	G2	C2
Northern redbelly-finescale dace	S3	G4	—
Blue sucker	S2	G4	C2

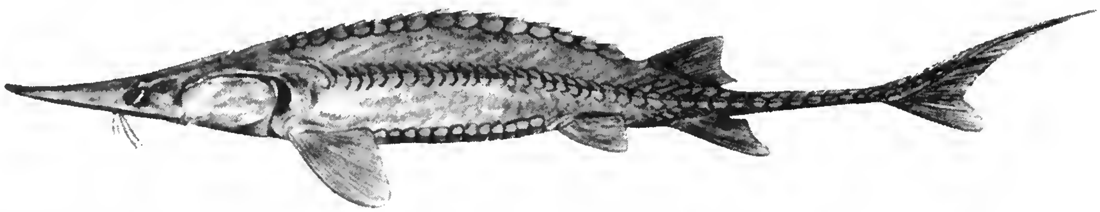
[a]State rank:
- S1 = Critically imperiled in Montana because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extirpation from the state (critically endangered in Montana).
- S2 = Imperiled in Montana because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state (endangered species).
- S3 = Rare in Montana (on the order of 20+ occurrences) (threatened in Montana).

[b]Global rank:
- G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction (critically endangered throughout range).
- G2 = Imperiled globally because of rarity (6 to 20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range (endangered throughout range).
- G3 = Either very rare and local throughout its range or found locally (even abundant at some of its locations) in a restricted range, or because of other factors making it vulnerable to extinction throughout its range; in the range of 21 to 100 occurrences (threatened throughout range).
- G4 = Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
- G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

[c]USFWS Status:
- C1 = Notice of Review, Category 1 (substantial biological information on file to support the appropriateness of proposing to list as endangered or threatened).
- C2 = Notice of Review, Category 2 (current information indicates that proposing to list as endangered or threatened is possibly appropriate, but substantial biological information is not on file to support an immediate ruling).
- C3 = Taxa that have proven to be more abundant or widespread than was previously believed, or that are not subject to any identifiable threat.

SOURCE: Montana Natural Heritage Program 1990

Figure 4-13. Pallid sturgeon *(Scaphirhynchus albus)*



Source: Brown 1971. Reprinted with permission from the Montana State University Foundation.

hydropower licensing, or federal funding of irrigation projects. USFWS can prohibit a federal action or propose an alternative course of action that would mitigate the impact to an endangered species or its critical habitat. Federal agencies may apply for an exemption to the requirements of the Endangered Species Act.

PALLID STURGEON

The pallid sturgeon is a boneless fish that can exceed 5 feet in length and weigh more than 60 pounds (Figure 4-13). The original distribution of the pallid sturgeon included the Mississippi River and large tributaries from Iowa to Louisiana, the Missouri River from Great Falls to the mouth, and the Yellowstone River below the mouth of the Tongue River (Gilbraith et al. 1988). Channelization and damming of these rivers have greatly reduced the migratory range of this fish. Between 1876 and 1983, only 12 sightings of pallid sturgeon were documented on the Missouri River between Fort Peck Dam and Great Falls (Cope 1876; Keenlyne 1989). In 1990 five pallid sturgeon were captured in the Missouri River below Cow Island (Gardner 1990). Overfishing, damming of the rivers, hybridization with the shovelnose sturgeon, and lack of reproduction are thought to have led to the decline of this species.

Little is known about the biology and habitat requirements of this fish. The pallid sturgeon is believed to spawn in flowing water in the spring, though it may not spawn every year. No small pallid sturgeon have been reported above Fort Peck Dam in the last 20 years, indicating that natural reproduction has been limited. Preferred habitats of sturgeon are reported to be flowing water over sand flats and gravel bars where they can eat aquatic insect larvae, mollusks, and small fish (Keenlyne 1989).

PADDLEFISH

The paddlefish is another boneless fish native to the Missouri and Yellowstone rivers in Montana (Figure 4-14). The largest paddlefish on record in Montana weighed 131 pounds, although they average 20 pounds and 50 inches in length (Brown 1971). During spring runoff, paddlefish migrate from Fort Peck Reservoir up the Missouri River presumably to spawn. Berg (DFWP 1989) identified nine such paddlefish concentration areas between Virgelle and Fort Peck Reservoir.

Though paddlefish feed only on microorganisms, they can be caught by snagging and are valued for their flesh and caviar. Processed paddlefish caviar can be sold for $300 to $500 per pound commercially (Federal Register 1990).

Figure 4-14. Paddlefish *(Polyodon spathula)*

Source: Brown 1971. Reprinted with permission from the Montana State University Foundation

Though paddlefish populations in Montana appear stable (Peterman 1990), populations in other states have suffered from overfishing, alteration of stream channels, and dams that block spawning migration.

Arctic Grayling

The arctic grayling is a member of the trout family and native to Montana. Its large, colorful dorsal fin distinguishes it from other Montana trout. The arctic grayling is valued as a game fish, reaching lengths up to 14 inches in Montana. Food requirements of the arctic grayling are similar to other trout except that it rarely eats other fish.

The arctic grayling was native to two areas in the lower 48 states: Michigan, where it is now extinct, and in the Missouri River drainage above Great Falls, where it was once abundant. The original range of the stream-dwelling grayling has been greatly reduced and is now limited to the Big Hole River, its tributaries, and the Sun, Red Rock, and Madison rivers in Montana (Brown 1971). Arctic grayling also live in lakes but depend on flowing water for spawning. Lake-dwelling grayling are abundant and apparently secure in Montana and other western states (Clark et al. 1989). Although the cause of decline in stream-dwelling arctic grayling populations has not been identified, low streamflows, changes in land use, and the introduction of non-native species may be among the contributing factors (McMichael 1990).

Westslope Cutthroat Trout

The westslope cutthroat trout is native to Montana west of the Continental Divide and in the Missouri River and its tributaries in the mountains east of the Continental Divide. Genetically pure westslope cutthroat trout are listed by MNHP as rare in Montana. Westslope cutthroat trout have decreased in numbers due to several factors: hybridization with non-native rainbow trout, competition from introduced species, overfishing, and habitat alteration (Liknes 1984). Although the current range of the westslope cutthroat trout is still being determined, it is estimated that genetically pure westslope cutthroat trout populations occupy only 1.1 percent of their historical range in Montana streams (Liknes 1984). Statewide, westslope cutthroat trout are found in 256 lakes, but genetically pure populations are found in only 16 lakes. Fifteen of these 16 lakes are in Glacier National Park. In the following subbasin descriptions, it is noted where populations of pure strain westslope cutthroat trout have been positively identified by laboratory analyses.

The westslope cutthroat trout is an important game fish in Montana. It can grow as large as 16 pounds where habitat conditions are favorable (Brown 1971).

Sturgeon Chub

The sturgeon chub is a member of the minnow family and is not a game fish. This fish lives in medium to large rivers that are turbid and warm, in areas of strong current with a sand or gravel bottom (Lee et al. 1980). It grows to be about 4 inches long. Brown (1971) notes, "This minnow is uncommon to rare in Montana and has no special value except as an interesting native species."

Sicklefin Chub

MNHP (1990) notes that the sicklefin chub is critically imperiled in Montana and rare throughout the rest of its range. The sicklefin chub is a member of the minnow family and may grow to 3.5 inches. It has been found along the lower portion of the Missouri River above Fort Peck Reservoir.

Northern Redbelly-Finescale Dace Hybrids

A hybrid fish is produced when northern redbelly dace are crossed with finescale dace. The offspring of this cross do not breed conventionally, but use a reproductive process in which egg cells are stimulated to divide and produce copies of their own genes. All offspring are females. These hybrids have been found in three locations in the Missouri River basin above Fort Peck Dam: the Musselshell River near Delphia, Eagle Creek, and Eureka Reservoir (Beer 1990).

Blue Sucker

Though secure globally, the blue sucker is rare in Montana. It has been found in the Missouri River below Fort Benton, the Marias River, the lower Judith River, and the lower portion of the Yellowstone River. Specimens weighing 16 pounds have been reported elsewhere, but most in Montana weigh less than 7.7 pounds (Brown 1971). The blue sucker is not a game fish in Montana, though it is said to be highly prized as a food fish in some areas (Brown 1971).

Headwaters Subbasin

Gallatin River Drainage

Reservations for instream use, consumptive use, or both have been requested on 25 streams in the Gallatin River drainage. These streams support populations of trout and whitefish (Appendix G). Nongame species frequently found in these streams

include longnose dace, mottled sculpin, and three species of suckers.

Baker Creek provides spawning habitat for brown trout from the Gallatin River (DFWP 1989). The east and west forks of Hyalite Creek provide spawning habitat for arctic grayling from Hyalite Reservoir. The state record arctic grayling was caught in Hyalite Reservoir. Besides the three streams where spawning has been confirmed, rainbow trout from the Gallatin River have been reported to congregate in Spanish and Squaw creeks, and in the West Fork of the Gallatin River during the spring (Nelson 1990). However, spawning has not been confirmed in these streams. North of Belgrade, three spring-fed streams, Reese Creek, Thompson Spring Creek, and Ben Hart Spring Creek, provide relatively stable flows and temperatures and, consequently, stable fish habitat.

Habitat conditions are generally good in the headwater streams, although sediment is a problem in some. Several streams in the Gallatin Valley suffer from summertime low flows (Table 4-2). Other water quality factors that may be affecting fish habitat are discussed under Water Quality.

The Gallatin River is one of the few streams in the state where enough information is available to show the relationship between streamflow and trout production. Figure 4-15 shows that reaches of the Gallatin River with low flows have fewer adult trout than reaches with higher flows.

Madison River Drainage

Reservations are requested on 26 stream reaches in the Madison River drainage. Appendix G shows the relative abundance of fish found in this drainage and the fisheries value class rating for each stream. The Madison River drainage supports populations of rainbow, brown, brook, and a few cutthroat trout. Nine streams have mountain whitefish, and four have arctic grayling. Other nongame fish species found in the drainage include mottled sculpins in most streams, two species of dace, three sucker species, a few stonecats, and an occasional perch.

The Madison River is nationally known as an outstanding fishery. It produces abundant wild trout, and angler use is very high by both resident and nonresident fishermen.

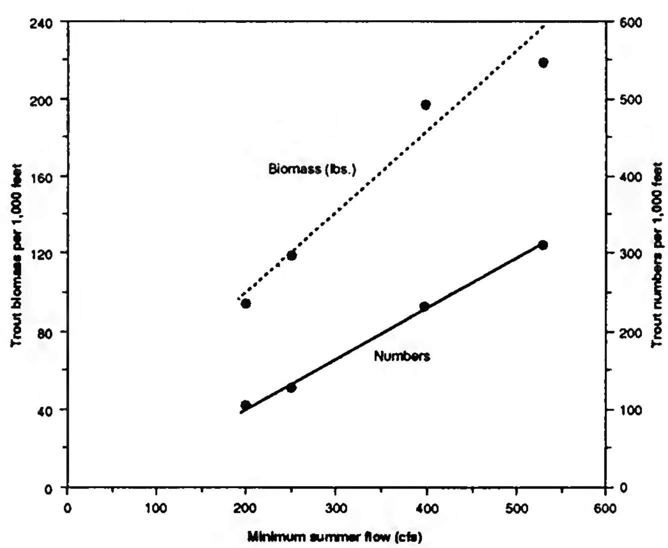
Stream-dwelling arctic grayling are found year-round in Standard Creek and the Madison River. Lake-dwelling arctic grayling spawn in Moore Creek and the South Fork of Meadow Creek. Genetically pure westslope cutthroat trout are believed to occur in Standard Creek, but laboratory analysis has not been performed to verify their genetic purity.

Trout populations in the Madison River and Hebgen, Earthquake, Cliff, and Ennis lakes depend on tributary streams for spawning and rearing habitat. Table 4-24 indicates the tributaries that provide this habitat.

Four spring creeks in the Madison River drainage, Whiskey, Black Sand, Blaine, and O'Dell creeks, have relatively stable flows and water temperatures and, consequently, provide a type of fish habitat different from that found in most streams. Blaine Spring Creek has one of the highest trout populations of any spring creek in southwest Montana.

Reduced flows, sedimentation, and elevated water temperatures are the major factors affecting aquatic habitat in the Madison River drainage. These factors are described in the water availability and water quality sections. Elevated water temperatures in the Madison River downstream from Ennis Lake adversely affect both aquatic habitat and trout populations. Water in the lake is relatively shallow and is warmed enough by the sun to reduce growth in trout downstream after its release.

Figure 4-15. Relationship between the minimum summer flow (cfs) and the estimated numbers and biomass (lbs) of adult trout in sections of the Gallatin River in September, 1976 and 1977



Adapted from Vincent and Clancy, 1980

Table 4-24. Madison River tributaries providing spawning and rearing habitat for game fish

Lake or stream where spawning run originates	Tributary stream	Fish species spawning in tributary streams
Hebgen Lake	Black Sand Spring Creek[a]	Rainbow trout, cutthroat trout, brown trout
	South Fork Madison River[a,b]	Rainbow trout, cutthroat trout
	Cougar Creek[b]	Brown trout, rainbow trout
	Duck Creek	Brown trout, rainbow trout
	Red Canyon Creek	Cutthroat trout, rainbow trout
	Watins Creek[a]	Cutthroat trout, rainbow trout
	Trapper Creek[a]	Cutthroat trout, rainbow trout
	Grayling Creek	Cutthroat trout, rainbow trout, brown trout
	Madison River	Rainbow trout, brown trout
Earthquake Lake	Cabin Creek[b]	Rainbow trout, brown trout, cutthroat trout
	Beaver Creek[b]	Rainbow trout, brown trout, cutthroat trout
Cliff Lake	Antelope Creek	Rainbow trout
Ennis Lake	North Meadow Creek[b]	Rainbow trout, brown trout
	Moore Creek	Arctic grayling
Madison River	Cherry Creek	Rainbow trout[b], brown trout, mountain whitefish
	Elk River[b]	Rainbow trout, brown trout
	West Fork Madison River[b]	Rainbow trout, brown trout
	Hot Springs Creek	Brown trout
	Whiskey Spring[b]	Brown trout

[a] DFWP is trying to establish a wild cutthroat trout spawning run in this stream. It is too early to determine the success of this stocking effort.
[b] A spawning run is believed to exist but has not been confirmed.

Jefferson and Boulder River Drainages

Reservations have been requested on 11 stream reaches in the Jefferson and Boulder River drainages. Appendix G shows that trout are common or abundant in most of these streams. Nongame fish found in these streams include mottled sculpins, three species of suckers, and three members of the minnow family. Halfway Creek is the only stream in this drainage known to support native, genetically pure westslope cutthroat trout.

Six tributary streams in this basin provide spawning and rearing habitat for trout from the Jefferson River or Willow Creek Reservoir. (Table 4-25.) Spawning habitat in the Jefferson River is thought to be limited, so trout in the river depend on spawning habitat in tributaries such as the lower reaches of the Boulder River and Hells Canyon Creek. Brown trout move up the lower portion of the Boulder River to spawn, and special fishing regulations have been instituted to protect these spawning fish. Rainbow trout from the Jefferson River spawn in the lower portion of Hells Canyon Creek, which may be one of the few spawning areas available to rainbow trout from the Jefferson.

Beginning in 1986 and continuing each year for three years, Trout Unlimited and DFWP planted a wild strain of rainbow trout in Willow Spring Creek. It is hoped that the young fish will move down into the Jefferson River to mature and eventually return to the creek to spawn.

Willow Creek and its tributaries, the North Fork and the South Fork, are examples of successful trout reintroduction efforts. Wild strains of rainbow trout were introduced into these streams and into Willow Creek Reservoir in an effort to eliminate the need to continually restock fish in the reservoir. Each year from 1981 to 1987, 1,000 to 3,500 rainbow trout ascended these creeks to spawn. DFWP collects eggs from trout in these creeks for rearing in hatcheries (DFWP 1989). As many as 1,000 brown trout from the reservoir also spawn in these streams (DFWP 1989).

In the Jefferson River aquatic habitat has been adversely affected by sediment and severely reduced

Table 4-25. Jefferson River tributaries providing spawning and rearing habitat for game fish

Lake or stream where spawning run originates	Tributary stream	Fish species spawning in tributary streams
Jefferson River	Hells Canyon Creek	Rainbow trout
	Willow Spring Creek[a]	Rainbow trout
	Boulder River (Reach 3)	Brown trout
Willow Creek Reservoir	South Willow Creek	Rainbow trout, brown trout
	North Willow Creek	Rainbow trout, brown trout
	Willow Creek	Rainbow trout, brown trout

[a] DFWP is trying to establish a rainbow trout spawning run in this stream. It is too early to determine the success of this effort.

summer flows. Toxic metals from past mining, streambank erosion, sediment, severely reduced summer flows, and elevated stream temperature have adversely affected aquatic habitat in the Boulder River.

Big Hole River Drainage

Instream reservations are sought on 46 streams in the Big Hole River drainage. Appendix G lists fish species, their relative abundance, and the fisheries value class rating for each stream in this drainage. In general, the Big Hole River and its tributaries support abundant populations of brook, rainbow, and cutthroat trout. Burbot, also known as ling, are present in many streams. Pure strain westslope cutthroat trout, a species of special concern, have been reported in Delano Creek. Arctic grayling, another species of special concern, are present in several streams.

The Big Hole River drainage supports a renowned fishery and is highly valued for its population of native stream-dwelling arctic grayling. Spawning by arctic grayling has been documented in the following streams in the Big Hole River drainage: Big Hole River and Big Lake, Rock, Steel, Deep, Terry, and Swamp creeks. Swamp, Big Lake, and Rock creeks provide spawning areas for grayling that live in the Big Hole River (Spence 1990). Besides providing spawning habitat for grayling, Deep and Terry creeks both provide spawning habitat for rainbow trout from the Big Hole River.

Several factors limit the grayling and trout fishery in the Big Hole drainage. Severely reduced streamflow leads to increased summer water temperatures and decreased dissolved oxygen, which may reduce production of aquatic organisms. Habitat alteration caused by stream channel stabilization and construction projects limit the fishery in some areas. Waste from past mining in some of the tributary streams may limit production of aquatic insects and fish.

Ruby River Drainage

Instream reservations are sought on 10 stream segments in the Ruby River drainage. Appendix G identifies the fish species present in these streams, their relative abundance, and the fisheries value class rating for each stream in this drainage. Trout and whitefish are the primary game fish found in this drainage. Nongame species include stonecats, longnose dace, mottled sculpins, three species of suckers, and carp. Westslope cutthroat trout are found in Coal and Greenhorn creeks, but laboratory analysis has not been performed to determine their genetic purity.

The lower reach of the Ruby River provides spawning habitat for brown trout from the Jefferson River, some of which migrate from as far downstream as Three Forks. Given the lack of known spawning areas in the Jefferson River, the spawning habitat in this reach of the Ruby River is important.

Warm Springs Creek flows into the Ruby River above Ruby Reservoir. Because the waters of Warm Springs Creek are warm and contain high concentrations of nutrients, trout populations in the Ruby River below the confluence are four-to-seven times higher than in other reaches. The warm water helps prevent icing that would stress fish in the Ruby during the winter. The additional nutrients allow more food organisms to be produced. Aquatic habitat in

the lower portion of the Ruby River suffers from low flows, while aquatic habitat above Ruby Reservoir suffers from deposition of fine sediments.

Red Rock and Beaverhead Drainage

Appendix G identifies fish species present in the Red Rock and Beaverhead river drainages, their relative abundance, and the fisheries value class rating for each of the 35 stream reaches where reservations are requested. Trout, whitefish, and arctic grayling are the most common game fish in this drainage, though a few burbot also are found. Nongame species include mottled sculpins, longnose dace, stonecats, four species of suckers, and carp. Two species of special concern are found in this drainage: westslope cutthroat trout and arctic grayling.

Most arctic grayling in the drainage live in Red Rock lakes and spawn in their tributaries. Stream-dwelling arctic grayling are thought to exist in Odell Creek, a tributary to Red Rock lakes, and in the reach of the Beaverhead River below East Bench diversion dam.

Pure strain westslope cutthroat trout are thought to occur in 12 tributaries: Jones, Pete, Indian, Cabin, Simpson, Shennon, Frying Pan, Trapper, Bear, Rape, Brown's Canyon, and Reservoir creeks. No laboratory analysis has been performed to verify the genetic purity of fish in these streams.

Besides providing habitat to resident fish, many of the streams support essential spawning and rearing habitat for game fish from other streams and reservoirs. Table 4-26 identifies streams used for spawning by fish from other areas.

Poindexter Slough, the most noted spring creek in the Red Rock/Beaverhead drainage, supports substantial populations of brown and rainbow trout. Most of the land near Poindexter Slough is managed as a public fishing access site.

Until recently, the Beaverhead River below Clark Canyon Dam supported numerous brown trout greater than 4 pounds and large numbers of smaller trout. Sampling in 1983 showed that this portion of the Beaverhead supported one of the largest populations of trout in the state. Beginning in 1988, droughts and severe drawdowns in Clark Canyon and Lima reservoirs have reduced flows and decreased trout numbers in the Beaverhead River below Clark Canyon (Spence 1988).

Low flows, siltation, metals contamination, and overgrazing of riparian vegetation are among the problems that have adversely affected aquatic habitat in these drainages.

Upper Missouri Subbasin

Missouri River - Three Forks to Holter Dam

Reservations are sought on 11 tributaries, Holter Reservoir, Canyon Ferry Reservoir, and the Missouri River. The predominant game fish in the Missouri River above Canyon Ferry are still whitefish and trout, but walleye have been introduced into Holter and Hauser reservoirs, and kokanee salmon are

Table 4-26. Red Rock and Beaverhead drainage tributary streams providing spawning and rearing habitat for game fish

Lake or stream where spawning run originates	Tributary stream	Fish species spawning in tributary streams
Clark Canyon Reservoir	Red Rock River (reach 2)	Brown trout, rainbow trout
	Horse Prairie Creek	Brown trout, rainbow trout
Red Rock Lakes	Red Rock Creek	Arctic grayling, cutthroat trout, rainbow/ cutthroat hybrid trout
	Tom Creek	Arctic grayling
	Odell Creek	Arctic grayling
Elk Lake	Narrows Creek	Arctic grayling, rainbow trout, cutthroat trout, rainbow/ cutthroat hybrid trout
Unnamed reservoir on Pete Creek	Pete Creek	Westslope cutthroat trout

found in Canyon Ferry, Holter, and Hauser reservoirs (Appendix G). Perch also are found in all three reservoirs. Smallmouth bass are being planted in Lake Helena, which is connected to Hauser Reservoir.

Most rainbow trout caught from Canyon Ferry are stocked, but about 5 percent are produced naturally from spawning in tributaries to the reservoir (Lere 1990). About 95 percent of the rainbow trout caught in gill nets set by DFWP in Hauser Reservoir are stocked (Lere 1990), with the remaining 5 percent originating from spawning in the tributaries. Brown trout reach trophy size in the three reservoirs. Brown trout are not stocked and depend on spawning in tributaries. Kokanee salmon have been stocked in the past, but the present population in Hauser Reservoir depends on natural reproduction. A large number of kokanee also spawn in the Missouri River immediately below Canyon Ferry and Hauser dams during the fall. Table 4-27 indicates the tributary streams used for spawning by fish from the reservoirs.

The Missouri River between Toston Dam and Canyon Ferry Reservoir is nationally known for producing large rainbow and brown trout during their spawning runs. Likewise, the 3.5-mile reach between Hauser Dam and Holter Reservoir has some of the densest trout populations in the state and provides spawning habitat for large rainbow and brown trout from Holter Reservoir.

Cutthroat trout are present in several streams (Appendix E). Because most of these streams also have rainbow trout, which hybridize with cutthroat trout (Liknes 1984), it is questionable whether genetically pure westslope cutthroat trout are present. Dewatering, sediment accumulation, and past mining activities have all affected aquatic habitat on tributaries, while low flows and dams affect habitat on the Missouri River.

MISSOURI RIVER FROM HOLTER DAM TO BELT CREEK

Between Holter Dam and Great Falls, instream or consumptive use reservations are sought on the main-stem Missouri River and on 18 tributaries. The diversity and population of fish species is notably higher in the Missouri than in most tributary streams. Fish more characteristic of warmer waters begin to appear in this reach, although the primary game fish are still trout and whitefish. Appendix G indicates the fish species and relative abundance found in this portion of the river and tributaries where reservations are requested. No species of special concern are present in this area.

The section of the Missouri River from Holter Dam to Cascade is rated by DFWP as a Class I sport fishery. This portion of the Missouri River supports abundant rainbow and brown trout and is highly regarded and heavily used by fishermen.

Table 4-27. Missouri River tributary streams providing spawning and rearing habitat for game fish in Canyon Ferry, Hauser, and Holter reservoirs

Lake or stream where spawning run originates	Tributary stream	Fish species spawning in tributary streams
Canyon Ferry Reservoir	Deep Creek	Rainbow trout
	Duck Creek	Rainbow trout
	Confederate Gulch	Rainbow trout
	Beaver Creek	Rainbow trout
	Missouri River	Rainbow trout, brown trout
Hauser Reservoir	Spokane Creek	Brown trout, kokanee salmon, mountain whitefish
	McGuire Creek	Brown trout, kokanee salmon
	Trout Creek	Rainbow trout, brown trout, kokanee salmon
	Prickly Pear Creek	Rainbow trout, brown trout
	Silver Creek	Rainbow trout, brown trout, kokanee salmon
	Beaver Creek	Rainbow trout, brown trout
Holter Reservoir	Cottonwood Creek	Rainbow trout
	Willow Creek	Rainbow trout, brown trout
	Missouri River	Brown trout, rainbow trout, kokanee salmon

Table 4-28. Missouri River tributary streams providing spawning and rearing habitat for game fish between Holter Dam and Great Falls

Lake or stream where spawning run originates	Tributary stream	Fish species spawning in tributary streams
Missouri River	Little Prickly Pear Creek	Rainbow trout, brown trout, white suckers, longnose suckers, mountain whitefish
	Lyons Creek	Rainbow trout, brown trout
	Wolf Creek	Rainbow trout
	Wegner Creek	Rainbow trout
	Stickney Creek	Rainbow trout

Trout in the Missouri River between Holter and Great Falls spawn in side channels where water depth and velocity are suitable. Spawning runs of rainbow and brown trout have been documented in these side channels and in tributaries. In 1988 it was estimated that 15,000 rainbow trout ascended Little Prickly Pear Creek to spawn (DFWP 1989). Table 4-28 identifies Missouri River tributaries between Holter Dam and Great Falls where reservations are requested to protect spawning and rearing areas for fish from the Missouri River.

Low flows (Table 4-4) during dry years, removal of riparian vegetation, and road construction are among the activities that have damaged aquatic habitat in the smaller streams in this area. Low flow problems are discussed earlier in this chapter.

Dearborn River Drainage

Reservations are sought on four streams and on Bean Lake in the Dearborn River drainage. Appendix G identifies the fish species present in the four streams, their relative abundance, and the fisheries value class ratings for each stream. Streams in this drainage support populations of trout and whitefish, and no species of special concern have been found.

The Dearborn River provides significant spawning habitat for rainbow trout from the Missouri River. Estimates indicate that approximately 20,000 rainbow trout ascend the Dearborn to spawn in the spring (DFWP 1989). Mountain whitefish spawn in the Dearborn during the fall.

Bean Lake is stocked annually with 40,000 rainbow trout fingerlings. These trout grow quickly and after two years weigh as much as 2.25 pounds. Fathead chubs and white suckers are also found in Bean Lake.

Streambank alteration and low flows damage aquatic habitat in the Dearborn River.

Smith River Drainage

Applications have been filed for consumptive or instream water reservations on 11 stream reaches in the Smith River drainage. Appendix G indicates streams that support populations of trout, whitefish, and a few burbot. Nongame species include longnose dace, mottled sculpins, three species of suckers, and an occasional carp and stonecat.

The westslope cutthroat trout is the only species of special concern found in the Smith River drainage. Laboratory analysis has confirmed that pure westslope cutthroat are found in the North Fork of Deep Creek. Other cutthroat trout are found throughout the drainage, but they may have interbred with species such as rainbow trout, producing hybridized strains.

Tenderfoot Creek is the only tributary stream used for spawning by trout from the Smith River. Walsh (1990) reports that both rainbow and brown trout from the Smith River spawn in the lower portion of Tenderfoot Creek.

Dewatering is one of the major factors affecting aquatic habitat in the Smith River drainage. Streams subject to low flows are described in the water availability section. In addition, removal of streamside vegetation and accumulation of fine sediments adversely affect aquatic habitat.

Sun River Drainage

The Sun River flows into the Missouri River at Great Falls. Appendix G identifies the fish species found in streams in the Sun River drainage where reservations are sought, their relative abundance,

and the fisheries value class of each stream. Headwater tributaries of the Sun River support populations of trout and whitefish and lesser numbers of northern pike, burbot, and yellow perch. Nongame species in the Sun River drainage include mottled sculpins, black bullheads, three species of suckers, longnose dace, flathead minnows, and carp. No species of special concern are found on streams where reservations are sought in this drainage.

Several storage reservoirs regulate flows in this drainage. The Sun River experiences severe dewatering above Muddy Creek due to irrigation diversions, despite the presence of upstream storage facilities. Severe low flows reduce aquatic habitat and increase stream temperatures.

Belt Creek Drainage

Belt Creek flows into the Missouri River about 2 miles below Morony Dam. Reservations are sought on eight streams in this drainage. Appendix G indicates the relative abundance of fish species found in the Belt Creek drainage and the fisheries value class of each stream where reservations are sought. Trout and whitefish are the most common game fish, although lower Belt Creek has some sauger. Nongame fish in the drainage include goldeye, carp, longnose dace, four species of suckers, and mottled sculpins. Except for pure westslope cutthroat trout in Pilgrim Creek, no species of special concern are found in this drainage.

The lower portion of Belt Creek is used for spawning by limited numbers of rainbow trout, brown trout, mountain whitefish, and sauger from the Missouri River. The 13-mile stretch of Belt Creek above Big Otter Creek does not maintain an adequate self-sustaining trout population and is stocked with rainbow trout. This reach has severe low flows and substantial fishing pressure.

Big Otter Creek relies on springs for much of its flow and has a flow pattern and aquatic community similar to those of a spring creek. The springs help to maintain a steadier flow regime than would otherwise be expected. The stream is fairly productive and provides habitat for rainbow and brown trout.

Low flows and water quality degradation from past mining have affected aquatic habitat in this drainage. Some of the flow reduction in Belt Creek occurs naturally as water from the stream recharges the groundwater aquifer.

Marias/Teton Subbasin

Marias River Drainage

Reservations are sought in 17 streams in the Marias River drainage and in Antelope Butte Swamp. The fisheries value class of each stream is shown in Appendix G, along with the relative abundance of each fish species present. Tributaries support populations of whitefish and trout, while the main-stem Marias supports much more diverse fish populations. The westslope cutthroat trout is the only species of special concern that resides year-round in this drainage. Westslope cutthroat trout are found in the North and South forks of Dupuyer Creek, North and South Badger creeks, Badger Creek, and the South Fork of Two Medicine River. The blue sucker, another species of special concern, migrates from the Missouri River to spawn in the Marias River. Antelope Butte Swamp contains a species of minnow that has not been identified (DFWP 1989).

The Marias River provides spawning and rearing habitat for fish from Tiber Reservoir and the Missouri River. Table 4-29 lists the species that spawn in the river.

Tiber Reservoir supports perch, walleye, northern pike, white sucker, burbot, carp, spottail shiner, rainbow trout, and black crappie (Hill et al. 1989).

Table 4-29. Origin of fish species spawning in the Marias River

Lake or stream where spawning run originates	Tributary stream	Fish species spawning in tributary streams
Tiber Reservoir (Lake Elwell)	Marias River above Tiber Dam	Walleye
Missouri River	Marias River (between the Missouri River and Tiber Dam)	Shovelnose sturgeon, sauger, walleye, channel catfish, blue sucker, smallmouth buffalo, bigmouth buffalo, freshwater drum

Data presented by these authors indicate that the size of walleye in the reservoir appears to be related to perch populations. Perch spawn in shallow areas of the reservoir, and young perch depend on submerged vegetation for survival. Negotiations are taking place among the Bureau of Reclamation, DFWP, irrigators, and sportsmen groups to plan how to supply adequate irrigation water while maintaining reservoir levels suitable for perch spawning. These same groups are negotiating releases from the reservoir to optimize water temperatures and flow levels for the rainbow and brown trout populations below Tiber Dam.

Teton River Drainage

Appendix G identifies the fish species found in the Teton River drainage, the relative abundance of fish species in each reach, and the fisheries value class for these streams. Fishery inventories on Teton River tributaries have shown that trout and mountain whitefish are the most common game fish. Other game fish found in the Teton River below Choteau include shovelnose sturgeon, northern pike, channel catfish, burbot, and sauger, but these species are uncommon or rare. Nongame fish include goldeye, carp, flathead and sturgeon chubs, emerald shiners, fathead minnows, longnose dace, six species of the sucker family, stonecats, and mottled sculpins.

The blue sucker and sturgeon chub, two species of special concern, inhabit the Teton River below Choteau. Westslope cutthroat trout, another species of special concern, are thought to be present in three tributary streams, the North Fork of Deep Creek, South Fork of Deep Creek, and Deep Creek, although their genetic purity has not been confirmed by laboratory analysis. Rainbow trout also are found in these streams and may have hybridized with the westslope cutthroat trout.

The lower portion of the Teton River goes dry, which adversely affects the fishery. DFWP has not applied for instream reservations in the lower Teton River.

Middle Missouri Subbasin

Missouri River from Belt Creek to Fort Peck Reservoir

Reservations are sought for water in the Missouri River between Morony Dam and Fort Peck Reservoir and from four small tributaries to this reach. As indicated in Appendix G, this portion of the Missouri supports the most diverse fishery in the basin above Fort Peck Dam.

Of the 80 species of fish reported to occur in Montana (Brown 1971), 39 are found in this reach, including five species of special concern. They include the pallid sturgeon, paddlefish, sturgeon chub, sicklefin chub, and blue sucker. A few pallid sturgeon have been reported in Fort Peck Lake and in the Missouri River upstream from the lake (Keenlyne 1989).

Although Montana appears to have a healthy population of paddlefish, USFWS is considering listing the paddlefish as a threatened species. Paddlefish are rare in parts of their historical range and possibly extinct in some states. In the period running generally between May 19 and July 5, paddlefish from Fort Peck Reservoir migrate up the Missouri River presumably to spawn. Berg (1981) found that paddlefish from the reservoir required a flow of 15,302 cfs for 48 days in the Missouri below Judith River before they would migrate.

Flows in this part of the Missouri River are regulated by upstream reservoirs. Present levels of summer water withdrawal on the main-stem Missouri do not seriously affect aquatic habitat in most years. The lower portion of Highwood Creek, a small Missouri tributary, is dry in most years.

Judith River Drainage

Reservations are requested on 21 stream reaches in the Judith River drainage. Appendix G indicates the fish species found in these streams, the relative abundance of fish in each, and the fisheries value class of each stream. Fishery inventories indicate that trout and mountain whitefish are the most common game fish. Other game fish in the lower part of the Judith River include sauger, channel catfish, smallmouth bass, walleye, and burbot. Nongame species found in the drainage include goldeye, cisco, four minnow species, six species of sucker, and mottled sculpin. The only species of special concern in this drainage is the blue sucker, which migrates from the Missouri River to the Judith River.

Two additional streams, Cottonwood and Big Spring creeks, provide spawning habitat for fish from other streams. Brown trout from the lower portion of Big Spring Creek spawn in Cottonwood Creek. Sauger from the Judith River are thought to spawn in the lower portion of Big Spring Creek. Low flows adversely affect aquatic habitat in portions of this drainage.

Musselshell River Drainage

Reservations are sought on 13 stream reaches in the Musselshell River drainage. Above the Deadmans Basin diversion, the drainage supports fish characteristic of cold water streams; trout and mountain whitefish predominate. A transition from a cold water to a warm water fishery takes place between the Deadmans Basin diversion and the Musselshell diversion about 80 miles to the east. This portion of the river supports sparse populations of brown trout, smallmouth bass, and channel catfish. Below the Musselshell diversion, the river supports warm water species, including sauger, channel catfish, smallmouth bass, black bullhead, northern pike, and walleye. Appendix G identifies the fish species found in streams in the Musselshell drainage where reservations are requested, the relative abundance of fish in each stream, and the fisheries value class of each stream.

The only fish species of special concern in this drainage is the northern redbelly-finescale dace hybrid. These fish were first identified in 1985 in the Musselshell River about 16 miles east of Roundup (DFWP 1989).

There is no documentation of fish moving from the Musselshell River to spawn in tributaries. However, the South Fork of the Musselshell may provide spawning habitat in very high flow years if brown trout can move past an irrigation diversion structure near the mouth. Big Elk Creek also may provide spawning habitat for brown trout from the Musselshell River.

The main factors affecting aquatic habitat in the Musselshell drainage are low flows caused by withdrawals, siltation, increased salinity, and addition of nutrients.

Fort Peck Reservoir and Tributaries

Reservations are sought from Fort Peck Reservoir and two small tributaries, Big Dry Creek and Little Dry Creek. The reservoir supports a diverse population of native and introduced species as shown in Appendix G. Big Dry and Little Dry creeks do not flow during parts of the year. However, spring runoff occasionally is high enough to allow fish to migrate from Fort Peck Reservoir. Walleye spawn in the streams when spring runoff permits. Young walleye, channel catfish, and nongame species also have been found in these streams near their mouths.

WILDLIFE

Wildlife habitat in the Missouri River subbasins upstream from Fort Peck Dam is some of the most productive and diverse in North America. This habitat supports species typical of the northern Great Plains and Rocky Mountains. Animals such as coyote, mule deer, and red-tailed hawk are widely distributed, whereas others such as sage grouse, sharp-tailed grouse, and pronghorn demonstrate specific habitat preferences. Mule deer, white-tailed deer, elk, and pronghorn exhibit seasonal habitat and range restrictions for wintering, breeding, and migration.

Riparian areas have the greatest diversity of breeding birds of any habitat in the basin. Many species such as saw-whet owl, great horned owl, red-tailed hawk, double-crested cormorant, and great blue heron nest in deciduous trees and shrubs along major rivers and streams. Nesting colonies of double crested cormorants and great blue heron are found in stands of mature cottonwood and cottonwood snags throughout the Missouri River subbasins. Sandhill cranes nest and feed in riparian areas, wet meadows, and pastures primarily in the Upper Missouri and Headwaters subbasins.

Waterfowl typically breeding in the Missouri River Basin include mallard, Canada goose, blue-winged teal, and common merganser. All the major rivers in the Missouri River subbasins provide important nesting habitat for Canada geese and ducks. DFWP found approximately 1,750 goose nests on the Missouri River between Three Forks and the Fred Robinson Bridge (Table 4-30). Other important goose nesting areas are the Marias River, both above and below Tiber Reservoir; the Jefferson River between Cardwell and Waterloo; and the lower Madison River.

Table 4-30. Number of goose nests observed on the Missouri River

River reach	Number of nests
Three Forks to Townsend	150
Canyon Ferry Game Management Area	451
Holter Lake to Great Falls	629
Morony Dam to Fred Robinson Bridge	522
TOTAL	1,752

Islands are critical nesting areas because surrounding water protects against predators. A major waterfowl production area has been constructed on the upper end of Canyon Ferry Reservoir by BUREC and DFWP. A series of dikes and ditches and over 330 man-made nesting islands provide nesting sites for more than 400 pairs of Canada geese and numerous ducks. Low water levels during drought years have exposed goose and duck nests to predation by foxes, skunks, raccoons, and other predators.

Osprey nest in snags in or near riparian areas and prey on fish in rivers, streams, and reservoirs in the Missouri River basin. A large osprey population nests along the Missouri River from Great Falls upstream to Three Forks.

Intermontane grasslands and shrublands in the Headwaters, Upper Missouri, and Marias/Teton subbasins provide year-round habitat for mule deer, pronghorn, sharp-tailed grouse, sage grouse, prairie falcon, ferruginous hawk, and Swainson's hawk. Both sharp-tailed grouse and sage grouse return year after year to the same sites (i.e., leks), where courtship and breeding take place. Sharptail leks typically are located in native grasslands, with nesting often occurring within a mile of a lek in dense stands of grasses and shrubs. Sage grouse typically nest in sagebrush/grasslands within 1 to 3 miles of leks.

Sage grouse are always associated with big sagebrush, a primary winter food and nesting habitat. Wintering areas located on large, flat expanses of sagebrush tall enough to remain partially exposed above the snow are critical habitat for sage grouse.

Mammals associated with aquatic and riparian ecosystems include river otter, beaver, muskrat, mink, and raccoon. These species are found throughout the Missouri River basin.

Pronghorn occur throughout the basin in sagebrush/grasslands. The primary winter food for pronghorn is sagebrush, whereas forbs (both native plants and agricultural crops) are important during other seasons.

White-tailed deer, although widely distributed in Montana, attain their highest population densities where riparian areas are interspersed with agricultural lands. All the major river valleys in the Missouri River subbasins have large populations of whitetails. Intermontane valleys in the Headwaters and Upper Missouri subbasins provide winter range for mule deer, white-tailed deer, and elk. Mule deer and elk typically migrate to lower elevations when snow becomes deep in the mountains. Winter range in the Headwaters and Upper Missouri subbasins generally is in narrow bands, bounded by high snowfall areas in the mountains upslope and valley bottoms with urban and agricultural activities at lower elevations. Winter range is the most important seasonal habitat because it is limited in area and has been eliminated or reduced by competing land uses such as residential subdivisions and agriculture.

Winter ranges in the prairie portions of the Marias/Teton and Middle Missouri subbasins are usually relatively large areas of land with a diversity of slopes, aspects, and topographic features. Winter range in these areas often is part of the year-round habitat.

Big game also forages on agricultural crops, which has been a problem throughout the Missouri River subbasins. Typically, game depredation on crops occurs where wintering animals are close to haystacks and crop fields. Elk and deer often break down haystacks and eat hay during the winter and are attracted in spring to the succulent early season growth in irrigated hayfields and dryland grain fields. Pronghorn antelope often are attracted to both hay and grain fields in spring and early summer.

Species of Special Concern

DFWP has identified vertebrate species of special concern (Flath 1984) that are known or suspected to live in the Missouri River study area. These species include animals listed under the Federal Endangered Species Act of 1973, as amended, and other species designated as rare, in need of additional research, or requiring special management. Table 4-31 lists sensitive species, their status, and possible presence within the Missouri River basin.

Of the 47 wildlife species of special concern identified for the Missouri River study area, about 14 would be expected to live in riparian areas or on upland grasslands and sagebrush-grasslands (i.e., lands likely to be affected by irrigation development projects) (Table 4-32). Threatened and endangered species, listed under the Endangered Species Act of 1973, that could be present on lands affected by irrigation projects are grizzly bear, gray wolf, bald eagle, peregrine falcon, whooping crane, least tern, and piping plover. In the past, the endangered black-footed ferret was a Montana resident, but it is thought to be extinct in the state.

Table 4-31. Species of special concern known to occur in the Missouri River subbasins

Species	Status	Location in Subbasin
Grizzly bear	Threatened	Headwaters, Upper Missouri, Marias/Teton
Wolverine	Undetermined	Headwaters, Middle Missouri, Upper Missouri, Marias/Teton
Lynx	Undetermined	Headwaters, Upper Missouri, Marias/Teton
Wolf	Threatened	Upper Missouri, Marias/Teton, Middle Missouri
Hoary marmot	Common	Upper Missouri, Marias/Teton
Spotted skunk	Undetermined	Headwaters
Blacktailed prairie dog	Undetermined	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Preble shrew	Undetermined	Marias/Teton, Middle Missouri
Dwarf shrew	Undetermined	Marias/Teton, Middle Missouri
Merriam shrew	Undetermined	Marias/Teton, Middle Missouri
Fringed bat	Undetermined	Headwaters
Big-eared bat	Undetermined	Headwaters, Marias/Teton, Middle Missouri
Dakota toad	Undetermined	Marias/Teton, Middle Missouri
Snapping turtle	Undetermined	Middle Missouri
Spiny softshell turtle	Undetermined	Middle Missouri
Milk snake	Rare	Middle Missouri
Plains hognose snake	Rare	Middle Missouri
Osprey	Common	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Bald eagle	Endangered	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Cooper's hawk	Undetermined	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Northern goshawk	Undetermined	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Ferruginous hawk	Rare	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Golden eagle	Common	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Merlin	Undetermined	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Peregrine falcon	Endangered	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Whooping crane	Endangered	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Upland sandpiper	Undetermined	Upper Missouri, Marias/Teton, Middle Missouri
Long-billed curlew	Undetermined	Upper Missouri, Marias/Teton, Middle Missouri
Burrowing owl	Undetermined	Upper Missouri, Marias/Teton, Middle Missouri
Long-eared owl	Undetermined	Upper Missouri, Marias/Teton, Middle Missouri
Mountain plover	Rare	Upper Missouri, Middle Missouri
Northern saw-whet owl	Undetermined	Headwaters, Upper Missouri, Marias/Teton
Olive-sided flycatcher	Undetermined	Headwaters, Upper Missouri, Marias/Teton
Eastern bluebird	Rare	Middle Missouri
Dickcissel	Rare	Marias/Teton
Clay-colored sparrow	Undetermined	Headwaters, Upper Missouri, Marias/Teton
Bobolink	Undetermined	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Harlequin duck	Rare	Upper Missouri, Marias/Teton
Pileated woodpecker	Undetermined	Upper Missouri, Marias/Teton
Barred owl	Undetermined	Upper Missouri, Marias/Teton
Northern pygmy owl	Undetermined	Headwaters, Upper Missouri, Marias/Teton
Great gray owl	Undetermined	Headwaters, Upper Missouri, Marias/Teton
Western bluebird	Rare	Headwaters, Upper Missouri, Marias/Teton
Brewer's sparrow	Undetermined	Headwaters, Upper Missouri, Marias/Teton, Middle Missouri
Least tern	Endangered	Middle Missouri
Piping plover	Threatened	Middle Missouri

Source: Flath 1984

Table 4-32. Sensitive species that might be found in vegetation communities likely to be affected by irrigation development projects

Species	Habitat
Blacktailed prairie dog	Sagebrush-grasslands
Merriam shrew	Sagebrush-grasslands
Osprey	Riparian areas (nesting)
Bald eagle	Riparian areas (nesting)
Ferruginous hawk	Sagebrush-grasslands (nesting)
Golden eagle	Sagebrush-grasslands
Upland sandpiper	Sagebrush-grasslands (nesting)
Long-billed curlew	Sagebrush-grasslands (nesting)
Burrowing owl	Sagebrush-grasslands (often nesting in association with prairie dogs)
Mountain plover	Sagebrush-grasslands (nesting)
Bobolink	Sagebrush-grasslands (nesting)
Brewer's sparrow	Sagebrush-grasslands (nesting)
Least tern	Riparian areas (nesting)
Piping plover	Riparian areas (nesting)

The grizzly bear is restricted to mountainous terrain in northwestern Montana and in south central Montana near Yellowstone National Park. Historically, the range of grizzly bear included the plains of eastern Montana. Grizzly bears in Montana still use the grasslands, riparian areas, and foothills along the Rocky Mountain front. The Rocky Mountain front is the only area in the United States where grizzlies use both mountains and plains. Grizzly bear habitat is located near potential irrigation projects in the Teton River drainage of the Marias/Teton Subbasin. The Teton River floodplain and riparian area is a travel corridor for grizzly moving between montane and prairie habitats along the Rocky Mountain front.

The gray wolf has, in recent years, been extending its range in northwestern Montana and is breeding successfully in Glacier National Park and along the adjacent mountain front northwest of Browning. Periodically, wolves are observed or killed in the prairie regions of central and eastern Montana. No proposed irrigation projects are located in habitat known to be occupied by wolves.

Bald eagles winter throughout the Missouri River drainage where fish, waterfowl, and carrion provide an adequate food base. They nest in all of the subbasins except for the Middle Missouri Subbasin. Of the 60 active nests observed in Montana in 1987, 13 were in the subbasins upstream from the confluence of the Marias and Missouri rivers (Aderhold 1988). Bald eagle nest sites are known on the Madison River south of Ennis, the Jefferson River near Twin Bridges, near the Ruby River, on the Missouri River downstream from Holter Lake, and near Holter Lake.

Peregrine falcons migrate through Montana and nest in the Headwaters Subbasin where they have been reintroduced at several previously occupied nest sites. Inactive peregrine falcon eyries, with the potential for reoccupancy, are known along the Jefferson River near Three Forks, the Marias River, Little Prickly Pear Creek, and Holter Lake. Peregrine falcons also have been reintroduced along the Missouri River north of Helena and in the Headwaters Subbasin near Lima.

Whooping cranes migrate through Montana, and over the last 28 years, there have been nearly 200 observations of these cranes in the state. Two-thirds of the whooping crane observations have been on or within 20 miles of Medicine Lake National Wildlife Refuge in extreme northeastern Montana. A few observations of whooping cranes also have been made at Red Rock Lake National Wildlife Refuge in the Headwaters Subbasin (Aderhold 1988).

In 1987, a pair of least terns was observed nesting on an island at the east end of Fort Peck Reservoir. The Middle Missouri Subbasin is the westernmost edge of the tern's range. The least tern also could breed on bare shorelines, islands, and sandbars along the Missouri River west of Fort Peck Reservoir.

The threatened piping plover is a shorebird that breeds in wetlands along Nelson Reservoir and Fort Peck Reservoir. In 1987, 74 adult plovers and 19 nests were observed in pebbly, sandy areas along major watercourses and scoured sandbars with little vegetation, their favored habitat.

In the past, the endangered black-footed ferret occupied portions of eastern Montana where there were large prairie dog colonies. The ferret depends almost entirely upon prairie dogs for food and shelter, and the decline of the ferret has been linked to eradication of prairie dogs. There have been no verified black-footed ferret sightings in Montana since 1979, when one was observed in Carter County near Ekalaka (Aderhold 1988).

VEGETATION

Plant communities in the four subbasins of the Missouri River above Fort Peck Dam reflect the integrated influences of soils, climate, physiography, and moisture. Predominant native plant communities include coniferous forests at higher elevations of foothills and mountains, shrublands and grasslands in the drier intermontane valleys, and riparian plant communities along rivers and streams where groundwater typically is close to the soil surface.

Plant communities most likely to be affected by water reservations and irrigated agriculture would be those growing in riparian zones and on upland sites with soils capable of sustaining irrigated agriculture. Therefore, these communities are addressed in greatest detail in this EIS.

In the Headwaters and Upper Missouri subbasins, Payne (1973) mapped the following four upland plant communities growing in intermontane valleys and foothills:

1. **Intermountain Valley Grassland and Meadow.** This community grows in major river valleys and is distinguished by meadow grasses, sedges, and needlegrass with willows on the wetter sites. Much of the valley land formerly occupied by this community has been converted to irrigated hay and dryland crops.

2. **Foothill Sagebrush.** This community grows on rolling foothills and is dominated by big sagebrush, rabbitbrush, fescues, and wheatgrasses. It is characterized by large areas of open, rolling grassland with rich topsoil. Sagebrush has increased in density on many sites due to heavy livestock grazing.

3. **Foothill Grassland.** This community grows on rolling foothills, wide valleys, and benches. Dominant grasses include wheatgrasses, fescues, and needle-and-thread. Sagebrush-dominated communities and conifer forests intergrade with this high elevation grassland.

4. **Teton River-Judith Basin Grassland.** This community is most widely distributed in north-central Montana, but extends southward to the drier sites in the Headwaters and Upper Missouri River subbasins. Much of the more fertile land in this community has been converted to dryland grain production. Dominant native species include blue grama, needle-and-thread, and prairie junegrass.

Major plant communities in the Marias/Teton and Middle Missouri subbasins are: Foothill Grassland, Teton River-Judith Basin Grassland, Northern Grassland, Central Grassland, and Sagebrush-Saltbrush (see previous descriptions for Foothill Grassland and Teton River-Judith Basin Grassland).

5. **Northern Grassland.** This community grows primarily on glacial till along the Missouri River valley. Dominant species include blue grama, western wheatgrass, needle-and-thread, threadleaf sedge, clubmoss, and fringed sagewort.

6. **Central Grassland.** This community grows predominantly on heavy clay and gravelly soils. Common plants include big sagebrush, prickley pear, fringed sagewort, Sandberg bluegrass, green needlegrass, prairie junegrass, and dryland sedge species.

7. **Sagebrush-Saltbrush.** This community grows primarily in Valley County on heavy clay alluvium, much of which is alkaline or sodic. Big sagebrush, Nuttall saltbrush, greasewood, and prickly pear are dominant shrubs. Common understory species include wheatgrasses, green needlegrass, Indian ricegrass, wild buckwheat, and scarlet globemallow.

Riparian or streamside vegetation comprises plant communities which grow in a transitional zone between aquatic and terrestrial ecosystems. Riparian plant communities have distinctive vegetation and soils and are characterized by the combination of high species diversity, high species density, and high productivity. River floodplains and riparian plant communities are dynamic, ever-changing biological systems, maintained in a state of arrested ecological development by floods. Floods periodically cause channel migrations (meanders) that expose gravel bars and scour the soil surface. Flood waters overtop the banks and spread out on the floodplain, where they deposit sediments.

Periodic sediment deposition and scouring by flooding are essential to the maintenance of deciduous riparian forests. Species such as cottonwood and willow require recently-deposited, exposed alluvium for seed germination and growth (Johnston et al. 1976; Fenner et al. 1985).

In the absence of periodic flooding, woody riparian plant communities attain maturity and decline. Large trees develop heart rot and are broken by wind. With losses in the overstory tree canopy and no

reproduction initiated by flooding, shrub, grassland, and conifer communities gradually replace cottonwood stands. According to Wilson (1970), cottonwood stands in South Dakota matured and started to decline after 50 years. Boggs (1984) also found that cottonwood communities along the Yellowstone River became greatly reduced in tree density and tree vigor after 92 years.

Cottonwood, willow, green ash, and box elder, dominant species of woody riparian communities, use groundwater within their rooting zones throughout the growing season. During the summer growing season, groundwater typically saturates floodplain soils underlying riparian cottonwood forests at a depth of 4 to 15 feet below the soil surface (Elliott 1987).

Riparian plant communities in the Headwaters and Upper Missouri subbasins are dominated by overstory of black cottonwood with common understory shrubs including red-osier dogwood, silver buffaloberry, chokecherry, Woods rose, Russian olive, and various willow species. In the Marias/Teton and Middle Missouri subbasins, black cottonwood is replaced by narrow-leaf cottonwood and eastern cottonwood as the dominant overstory. Eastern cottonwood, box elder, and green ash are dominant components of the forest overstory in the Middle Missouri Subbasin. Common shrubs include Woods rose, silver sagebrush, western snowberry, and willows.

Sensitive Plants and Plant Communities

No Montana plants are listed as threatened or endangered under the Federal Endangered Species Act, but the Montana Natural Heritage Program has identified rare, endangered, threatened, and sensitive plants and plants of limited distribution in Montana (Shelly and Lesica 1990). These plants have no legal status that would require special management or efforts to avoid them on state or private lands; however, the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) have adopted policies that preserve species that are candidates for classification under the federal act. Based on known distribution and habitat characteristics, 10 species could grow on areas to be developed for irrigation or municipal water projects (Table 4-33).

Plant species and plant communities with high biological values also occur in the Missouri River subbasins. Riparian cottonwood forests and wetlands provide important wildlife habitat, serve as storage areas for floods, and influence the surface water and groundwater hydrology of rivers and streams.

Table 4-33. Sensitive plants that could be affected by irrigation development projects

Species	Status	Subbasin of occurrence	Habitat
Astragalus convallarius (Timber milkvetch)	Sensitive[a]	Headwaters, Upper Missouri	Sagebrush/grasslands
Astragalus platytropis (Broad-keeled milkvetch)	Sensitive[a]	Headwaters	Sagebrush/grassland benches
Camissonea scapoidea (Naked-stemmed evening-primrose)	Sensitive[a]	Middle Missouri	Grasslands
Carex crawei (Craw's sedge)	Sensitive[a]	Marias/Teton	Gravelly streambanks
Cyperus acuminatus (Short-pointed flatsedge)	Sensitive[a]	Upper Missouri	Wet streambanks
Delphinium andersonii (Anderson's larkspur)	Sensitive[a]	Headwaters	Sagebrush valleys and hills
Rorippa calycina (Persistent-sepa yellowcress)	Sensitive/C2[b]	Upper Missouri, Middle Missouri	Riverbanks
Sidalcea oregana (Oregon checker-mallow)	Sensitive[a]	Headwaters	Valley meadows and grasslands
Sporobolus neglectus (Small dropseed)	Sensitive[a]	Headwaters	Valley grasslands
Oxytropis lagopus (Rabbit-foot crazyweed)	Limited distribution[c]	Upper Missouri, Marias/Teton	Sagebrush/grasslands

Notes:

a Sensitive plants are those known from a limited number of populations in Montana, or those that occur principally in restricted habitats considered vulnerable to man-caused disturbances.

b C2 plants are considered by the federal government to be imperiled globally and may be vulnerable to extinction throughout their ranges.

c Species of limited distribution are plants found only in small areas of Montana, but considered too abundant to be sensitive.

Source: Shelly and Lesica 1990

The federal government considers wetlands to be a productive and valuable public resource, and "the unnecessary alteration or destruction of such resources should be discouraged as contrary to the public interest" (33 CFR Part 320). Under Section 404 of the Clean Water Act, wetlands are defined as:

> Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands in the Missouri River subbasins include swamps, marshes, oxbows of rivers, subirrigated meadows, and portions of floodplains. Alteration of wetlands through dredging or filling would require a Section 404 Permit from the U.S. Army Corps of Engineers.

Noxious Weeds

Noxious weeds are usually exotic plants that proliferate and reduce the value of land for agriculture, forestry, livestock, wildlife, and other beneficial uses. Noxious weeds spread rapidly, outcompete most native species, and have at least some of the following characteristics:

1. Continuous seed production during the growing season
2. Highly efficient seed dispersal
3. Persistent banks of seeds or seedlings
4. Capability for growth in adverse climates and soils
5. Capability to reproduce through seeds, sprouts, and rhizomes (Montana Department of Agriculture 1981; McDonald and Tappeiner 1986)

Table 4-34 lists plants that have been classified as noxious weeds throughout Montana. Weed control districts may add local problem species to this list.

Noxious weeds that pose the most serious economic and land use problems in the Missouri River drainage are spotted knapweed, leafy spurge, and Canada thistle. These species have infested approximately 13,080 acres in the Headwaters Subbasin, 460,800 acres in the Upper Missouri River Subbasin, 1,208,570 acres in the Marias/Teton Subbasin, and 1,095,570 acres in the Middle Missouri Subbasin (Table 4-35).

Table 4-34. Montana noxious weeds

Common Name	Scientific Name
Category 1 (currently established in Montana)	
Canada thistle	*Cirsium arvense*
Field bindweed	*Convolvulus arvensis*
Whitetop	*Cardaria draba*
Leafy spurge	*Euphorbia esula*
Russian knapweed	*Centaurea repens*
Spotted knapweed	*Centaurea maculosa*
Diffuse knapweed	*Centaurea diffusa*
Dalmatian toadflax	*Linaria dalmatica*
St. Johnswort	*Hypericum perforatum*
Category 2 (recently introduced or not yet detected in Montana)	
Dyers woad	*Isatis tinetoria*
Yellow starthistle	*Centaurea solstitalis*
Common crupina	*Crupina vulgaris*
Tansy ragwort	*Senecio jacobaea*
Rush skeletonweed	*Chondrilla juncea*

Source: *Administrative Rules of Montana* 4.5.201-203 et seq.

Table 4-35. Estimated acreages of noxious weeds for counties with proposed irrigation projects

Weed Species	Headwaters Subbasin	Upper Missouri Subbasin	Marias/Teton Subbasin	Middle Missouri Subbasin
Spotted knapweed	2,000	113,200	94,900	37,520
Canada thistle	9,080	315,600	1,066,500	1 ,030,000
Russian knapweed	190	1,000,580	26,905	1 ,305
Leafy spurge	2,000	32,000	47,170	28,050
Whitetop	400	12,110	15,540	1,015
Dalmation toadflax	1,205	6,290	1,115	2,004
Field bindweed	5,050	550	3,805	45,000
Diffuse knapweed	162	101,260	45	505
Total	20,087	1,581,590	1,255,980	1,145,399

Source: Cooksey

Noxious weeds typically infest areas disturbed by grazing, crop production, and linear facilities such as highways, roads, and transmission lines. Most infestations are present in river valleys where linear facilities and crop production are concentrated; however, spotted knapweed and leafy spurge extend upslope into foothills, become dominant species, and reduce the abundance and diversity of native plants. This reduction in abundance and diversity decreases the quality of wildlife habitat, particularly big game winter range.

HISTORICAL, ARCHAEOLOGICAL, AND PALEONTOLOGICAL RESOURCES

The proposed irrigation projects would be developed on floodplains, terraces, and benchlands above the Missouri River and its tributaries. These landscapes have the potential to contain historic and prehistorical evidence of Montana's past. A wide variety of activities are known to have occurred in the study area, some of which are reflected in recorded sites identified through file searches conducted by the State Historic Preservation Office (SHPO) at DNRC's request. Table 4-36 lists sites that might be affected by irrigation projects or municipal reservation development.

There has been no systematic on-the-ground survey of historical and archeological resources on land to be developed by the various irrigation and municipal projects. About two-thirds of these lands are cultivated at present, reducing the potential for discovery of intact cultural artifacts. Undisturbed range or pastureland is more likely to contain undiscovered cultural resource sites.

The Missouri River basin has outcrops of a number of geologic formations known to produce fossils from the Cretaceous period. Fossils are occasionally found in sedimentary deposits of a type that occurs in the Missouri basin. Many fossils, including fossilized plants and marine invertebrates, are common and, with rare exceptions, have little scientific value. Fossilized reptiles, fish, dinosaurs, and mammals have more scientific value. The discovery of fossilized bone, or the rare complete skeleton, is considered to have moderate to high paleontological significance. Most Montana fossil finds of scientific significance have been in areas not suitable for the development of irrigation. For example, fossil finds often occur in badlands where topography or soil type limits agricultural activities, or in areas of rock outcrop such as cliffs. In contrast, the proposed irrigation projects are located on floodplains, terraces, and benchlands where geologic processes such as glaciation or other depositional environments limit the possibilities that important fossils would remain intact.

HEADWATERS SUBBASIN

Many of the streams in this subbasin have no consumptive use projects proposed for development. Thus while a wide variety of activity is known to have occurred in the subbasin, most sites would not be affected by the reservations. One site listed on the National Register of Historic Places, the Three Forks of the Missouri National Historic Landmark, nearby Headwaters State Park is present in this subbasin and could be affected by the reservation process.

UPPER MISSOURI SUBBASIN

Based on the present understanding of prehistoric and historic use and activities known to have occurred in this subbasin, several areas are likely to yield additional archaeological or historical information. Areas with moderate to high potential for new site discovery are at the confluences of the Missouri River with its tributary streams such as Belt Creek and the Smith River, and on the terraces and benchland above the Smith and Sun rivers. These areas reflect a higher density of known sites and exhibit potential to yield new sites or additional information about the past use of these areas.

MARIAS/TETON SUBBASIN

Projects in this subbasin would be developed on landscapes surrounding the Marias and Teton rivers and tributaries. These areas have the potential to contain historical and archaeological evidence of past use. Several prehistoric sites eligible for listing on the National Register of Historic Places have been identified in such landscapes in the basin. Much of the area proposed for irrigation development is presently cultivated. Only about 1,350 acres of rangeland would be converted. This subbasin contains areas known to contain invertebrate fossils, including the Two Medicine Formation famous for the Egg Mountain fossil discovery west of Choteau.

MIDDLE MISSOURI SUBBASIN

The distribution of known sites and expected potential for new site discovery in this basin increase in

Table 4-36. List of known historical, archaeological, and paleontological sites that may be affected by the proposed water reservations

Site number	Eligibility/ Significance	Site type
HEADWATERS SUBBASIN		
24GA0212	Eligible	Three Forks of the Missouri National Historic Landmark
24JF0062	Unknown	Stone circle/cairns
24MA0717	Unknown	Historic wooden bridge
24JF0755	Potentially eligible	Prehistoric occupation site
24GA0761	Unknown	Lithic scatter, bone fragments
24GA0762	Unknown	Rock cairn, tipi rings, lithics
24GA0634	Not eligible	Lithic chipping site/lookout
24GA0757	Unknown	Prehistoric habilitation site
24GA0759	Unknown	Historic dugout
UPPER MISSOURI SUBBASIN		
24BWO256	Potentially eligible	Lithic workshop and procurement site
24BW0292	Unknown	Oligocene/Miocene fossil site
24BWO047	Unknown	Tipi rings
24BWO054	Unknown	Lithic scatter
24BW0202	Unknown	Miocene fossil site
24BW1043	Unknown	Tipi ring
24BW0291	Unknown	Oligocene fossil site
24BW0499	Not eligible	Historic irrigation system (Broadwater/Missouri Canals)
24CA0023	Unknown	Buffalo jump
24CA0285	Unknown	Prehistoric campsite
24CA0016	Unknown	Buffalo jump
24CA0070	Unknown	Prehistoric campsite
24CA0017	Unknown	Buffalo jump
24CA0040	Unknown	Buffalo jump
24CA0036	Unknown	Prehistoric campsite; historic army portage site
24CA0074	Eligible	Lithic scatter; prehistoric occupation
24CA0241	Unknown	Historic wooden bridge
24CA0243	Unknown	Historic wooden bridge
24LC0177	Unknown	Rockalignment/tipiring/hearth
24LC1030	Unknown	Tipi ring
24LC0757	Not eligible	Historic Hiett residence
24LC0758	Not eligible	Historic Anderson Ranch
24LC0632	Unknown	Tipi rings/lithic scatter
MARIAS/TETON SUBBASIN		
24LT0027	Not eligible	Cairns
24LT0029	Not eligible	Cairn
24LT0030	Not eligible	Cairn
24LT0032	Unknown	Hearth/roast pit
24LT0033	Not eligible	Cairn
24LT0034	Not eligible	Cairns
24TL0077	Not eligible	Tipi rings/cairn
24TT0039	Unknown	Tipi rings
24CH0381	Potentially eligible	Prehistoric habitation site
24CH0458	Unknown	Lithic scatter
MIDDLE MISSOURI SUBBASIN		
24CH0179	Unknown	Prehistoric campsite
24CH0292	Unknown	Historical travel route
24CH0284	Unknown	Lithic workshop
24CH0484	Not eligible	Historic Churchill Homestead
24CH0215	Unknown	Cairn/tipi ring/hearth
24CH0343	Unknown	Historic Blankenbaker Homestead
24CH0181	Unknown	Prehistoric lithic workshop
24CH0182	Unknown	Prehistoric campsite
24CH0210	Unknown	Kill site; rock drive lines
24CH0585	Potentially eligible	Great Northern Railroad Guide and Station House
24VL0027	Not eligible	Rock caims/tipi ring
24FR0411	Not eligible	Historic railroad
24FR0570	Unknown	Historic white site
24FR0571	Unknown	Historic white site
24FR1194	Unknown	Historic irrigation/ conservation system
24FR0201	Unknown	Tipi ring
24FR0202	Unknown	Lithic scatter
24FR0204	Unknown	Historic Camp Cook
24FR0206	Unknown	Possible burial site
24FR0207	Unknown	Possible burial site
24FR0208	Unknown	Campsite
24FR0211	Unknown	Historic wood irrigation pipe
24FR0214	Unknown	Historic trade post/midden
24ML0373	Not eligible	Historic Geoffena ditch system

Source: Compiled from information provided by SHPO and University of Montana archaeological records

areas such as the confluence of the Missouri River with Arrow Creek, the Judith River, and the Marias and Teton rivers. Historically significant sites associated with the Lewis and Clark expedition, later steamboat use, and settlement activities have been found in the landscapes above this portion of the Missouri basin.

Large areas on the Charles M. Russell Wildlife Range are known to contain fossils, including complete skeletons of mammals, dinosaurs, and reptiles.

RECREATION

PATTERNS OF RECREATION PARTICIPATION IN MONTANA

Results from two comprehensive studies show stability in the proportion of Montana residents that participated in outdoor recreation between 1979 and 1985 (Wallwork et al. 1980; Frost and McCool 1986). Participation rates for outdoor activities changed little from 1979 to 1985 (Table 4-37).

If Montana's adult population increases by 20 percent between 1985 and 2000 and the state's population grows older in line with national trends, then the number of Montanans participating in outdoor recreation also will increase as shown in Table 4-38 (McCool and Frost 1987). Some activities will increase less than others because the population will be older. A recent study (Albert et al. 1989) indicates that Montana's population may actually decline by 1.4 percent by the year 2000, suggesting a smaller predicted growth in recreational activities than predicted.

The most popular recreational activities of picnicking, walking for pleasure, camping, and fishing can be enjoyed by several age classes. The number of participants is expected to increase in these activities (McCool and Frost 1987). Activities favored less by older people, such as alpine skiing or riding all-terrain vehicles, should show a smaller increase in the future. Fishing is the most popular water-based recreational activity for Montanans and is expected to remain so.

Table 4-37. Participation rates for 11 outdoor recreational activities: 1979 and 1985

Activity	1979 Percent Participating	1979 Median Days	1985 Percent Participating	1985 Median Days
Picnicking	77.5	6	74.8	6
Walking for pleasure	71.9	20	77.1	30
Fishing	58.5	14	56.4	12
Camping	57.6	10	51.9	8
Hunting	35.2	10	37.6	10
Bicycling	32.8	20	38.6	20
Motor boating	32.5	6	32.6	5
Bird watching/ nature study	29.4	25	31.8	21
Horseback riding	18.8	10	22.3	6
Snowmobiling	14.8	5	16.3	5
Cross-country skiing	14.6	6	18.6	7

Source: McCool and Frost 1987

Table 4-38. Estimated numbers of adult Montanans participating in recreational activities, 1985-2000

Activity	Number of Participating Montanans, 1985	Number of Projected Participating Montanans, 2000	Percent Growth
Picnicking	434,700	516,900	19
Day hiking	452,500	537,500	19
Fishing	326,000	386,500	19
Camping	300,700	352,100	17
Hunting	214,200	253,200	18
Bicycling	222,100	249,900	12
Motor boating	191,400	222,100	16
Nature study	187,800	226,100	20
Horseback riding	128,700	146,200	14
Snowmobiling	96,100	108,200	12
Nordic skiing	104,000	122,100	17
Backpacking	81,300	92,300	14
Jogging	139,400	152,900	10
Off-road 4WD	142,000	165,300	16
Motorcycles or ATV	68,900	74,800	9
Canoeing	65,200	72,100	11
Rafting	104,100	117,100	13
Pool swimming	202,400	236,200	17
Lake or stream swimming	243,700	275,200	13
Waterskiing	84,600	93,000	10
Alpine skiing	109,500	119,600	9
Iceskating	72,700	83,500	15

Source: McCool and Frost 1987

RECREATION IN THE MISSOURI BASIN

DNRC RECREATION SURVEY RESULTS

DNRC conducted a recreation survey and economic study of instream flows in the Missouri River basin above Fort Peck Dam during the fall of 1989 (Duffield et al. 1990). Information was collected on patterns of use for 25 rivers and reservoirs in the basin, the economic value people place on water-related activities, and how these activities and values are affected by water levels and flows. The survey also estimated the degree of statewide participation and nonparticipation in water-related recreation. A total of 9,000 questionnaires were mailed—6,000 to residents of the Missouri River basin above Fort Peck Dam, 2,000 to out-of-basin Montana residents, and 1,000 to holders of nonresident conservation licenses. The response rate was 54 percent.

The survey showed that significant recreation values are placed on Missouri basin water. Over 2 million recreation days were reported for Missouri basin lakes and streams in 1989. Eighty-four percent of all adult Montanans participate in water-related recreation such as fishing, boating, and shoreline activities, which include picnicking, swimming, sightseeing, and camping. On basin rivers and streams, anglers accounted for 42 percent of total resident use, boaters and floaters 17 percent, and shoreline recreationists 42 percent. Statistics for reservoirs differ slightly, with anglers accounting for 50 percent of total use, floaters and boaters 17 percent, and shoreline recreationists 33 percent.

Montanans highly value the opportunity to visit and use rivers and streams for recreation. Ninety-eight percent either agreed or strongly agreed with the statement that they enjoy knowing that friends and family can visit rivers for recreation if they want to. Montanans also believe that water quality in rivers and streams is important, with 79 percent agreeing that water quality in streams and rivers in their area of Montana should be improved. Use of Montana's water for irrigation generates diverse opinions, with 46 percent of Montanans agreeing that irrigation is the most important use, 42 percent disagreeing, and 11 percent expressing no opinion (see Table 4-39).

Low water in rivers, streams, and reservoirs can substantially affect the number and quality of recreation trips. Fifty-two percent of in-state respondents took fewer trips to Missouri basin rivers and reservoirs in 1988 because of low water. Almost two-thirds of respondents (65 percent) noted lower trip quality in 1988 because of low water. From 16 to 25 percent of respondents participated less in fishing, boating and floating, and shoreline activities in 1988 because of low water.

Survey results also provided estimates of recreation use days, expenditures, and the economic value of recreation trips. These are shown in the following tables.

Table 4-40 shows total recreational use days by Montana residents and nonresidents in the subbasins (Duffield et al. 1990).

Table 4-39. Attitudes of Montanans on water quality and use (based on the 1989 DNRC recreation survey)

	Percentage of Montanans who:				
	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion
I enjoy knowing that my friends and family can visit rivers for recreation if they want to.	70	28	—	—	2
Water quality in streams and rivers in this area of Montana should be improved.	33	46	7	1	13
I think irrigation is the most important use of Montana's water.	15	31	35	7	11

Table 4-40. Total recreation use days in 1989

Subbasin	Residents (thousands of use days)	Nonresidents
Headwaters		
Rivers	349 to 478	136 to 220
Reservoirs	49 to 115	33 to 70
Upper Missouri		
Rivers	299 to 521	12 to 21
Reservoirs	278 to 456	7 to 16
Middle Missouri and Marias/Teton		
Rivers	165 to 312	3 to 16
Reservoirs	194 to 366	2 to 8
All subbasins[a]		
Rivers	949 to 1,191	163 to 250
Reservoirs	608 to 860	50 to 94

[a] The range of results for all subbasins is smaller than for individual subbasins due to a larger sample size.

Source: Duffield et al. 1990

NOTE: Subbasin boundaries used in the survey differed slightly from those in this EIS.

Table 4-41 shows average recreation expenditures per person per day by activity for rivers and reservoirs in each of three subbasins.

Table 4-42 shows total recreational expenditures in the subbasins by Montana residents and nonresidents (Duffield et al. 1990). Figures shown are considered at least 95 percent accurate.

People normally will buy something, including water-based recreation, only if it is worth at least what it costs. The survey asked people whether they would have taken a trip to a river if their costs had been higher by a certain amount. Those who answered yes showed that the trip was worth at least that much more than their actual costs. This fact was used to estimate the difference between the value people place on recreation and their expenditures. This difference between worth and cost is often termed net economic value and is shown in Table 4-43.

Results of Outfitter Survey

During the spring of 1990, the Department of Natural Resources and Conservation conducted a telephone survey of 102 Montana outfitters who provide guiding services in the Missouri River basin (Economic Consultants Northwest 1990). Information was collected on outfitter use of the rivers and streams within the Missouri River basin above Fort Peck Dam, the effect of decreased streamflows on outfitters' activity, and outfitters' economic contribution to Montana from their use of Missouri basin rivers and streams.

Survey results show that trips to Headwater streams account for most of the outfitting activity in the Missouri basin. Trips to the Big Hole and Madison rivers together accounted for 59 percent of estimated total trips during the 1989 fishing and floating season. Remaining trips were distributed among other rivers (Table 4-44).

Table 4-41. Recreation expenditures per day

Subbasin	Activity	Rivers	Reservoirs
Headwaters	Shore fishing	$25.13	$38.55
	Boat fishing	$43.06	$44.84
	Boating/floating	$42.36	$82.50
	Shoreline[a]	$32.17	$27.57
Upper Missouri	Shore fishing	$75.49	$33.64
	Boat fishing	$85.34	$38.68
	Boating/floating	$44.45	$55.05
	Shoreline[a]	$37.44	$30.67
Middle Missouri and Marias/Teton	Shore fishing	$41.76	$57.26
	Boat fishing	$27.44	$33.63
	Boating/floating	$41.55	$41.28
	Shoreline[a]	$29.66	$48.48

[a] Picnicking, camping, swimming, sightseeing, etc.
Source: Duffield et al. 1990
Note: Subbasin boundaries used in the survey differed slightly from those in this EIS.

Table 4-42. Total annual recreation expenditures

Subbasin	Residents (millions of dollars)	Nonresidents (millions of dollars)
Headwaters	12.1 to 23.9	27.9 to 48.2
Upper Missouri	23.0 to 38.1	2.4 to 6.0
Middle Missouri and Marias/Teton	14.4 to 27.3	3.0 to 6.0
All subbasins[a]	57.9 to 81.0	33.7 to 54.5

[a] The range of results for all subbasins is smaller than for individual subbasins due to a larger sample size.
Source: Duffield et al. 1990

Table 4-43. Total net economic value of recreation trips

Subbasin	Residents (millions of dollars)
Headwaters	
Rivers	13.1 to 30.4
Reservoirs	1.1 to 5.3
Upper Missouri	
Rivers	11.4 to 38.0
Reservoirs	12.0 to 24.4
Middle Missouri and Marias/Teton	
Rivers	8.7 to 22.7
Reservoirs	5.6 to 16.8
All subbasins[a]	75.4 to 114.1
	Nonresidents
All subbasins[a]	35.3 to 63.2
Rivers	27.2 to 52.8
Reservoirs	3.7 to 14.8

[a] The range of results for all subbasins is smaller than for individual subbasins due to a larger sample size.
Source: Duffield et al. 1990

The majority of the respondents reported that the primary activity of their guiding trips was boat fishing, except on the Gallatin River and the Missouri below Great Falls. The primary activity of the guiding trips on the Gallatin was equally divided among boat fishing, shore fishing, and other activities, such as wading, sightseeing, and guided white water boating. Activity on the Missouri below Great Falls was divided between hunting and fishing.

When asked about effects of drought and decreased streamflows on their outfitting business during 1988 and 1989, 57 percent of surveyed outfitters indicated that the number of trips taken had declined due to decreased water levels in the rivers (Table 4-45). More than half (62 percent) of the outfitters said low flows had reduced the length of the floating season, and 46 percent said the number of clients served was reduced. Other effects noted were increased fishing pressure and crowding on streams with adequate flow, a decline in the recreational quality and ecological integrity of rivers, more difficult passage for boats or rafts on rivers, and reduced economic return to outfitters and the state.

Seventy-four percent of surveyed outfitters indicted there were rivers that they used less or did not use during the 1989 floating/fishing season because of decreased streamflows. The Big Hole, Beaverhead, Jefferson, and Smith rivers accounted for 77 percent of all responses. Approximately two-thirds (69 percent) of the respondents reported substituting another river or stream in response to decreased streamflows. Substitute rivers most often named by respondents were the Madison, Missouri, and Yellowstone rivers. These three rivers accounted for 60 percent of all substitute rivers named—the Madison with 26 percent and the Missouri and Yellowstone with 17 percent each.

Based on survey results, the economic impact to the state in 1989 from river guiding in the Missouri basin above Fort Peck Dam included $9.7 million in direct expenditures for guiding services, lodging, travel, food, and other related costs. Each dollar of expenditures stimulates secondary expenditures in the economy, such as those that occur from the increased earnings of employees of outfitters. Secondary benefits of $23.0 million were estimated using an impact multiplier of 2.39 developed by the Institute for Tourism and Recreation Research of the

Table 4-44. Estimated number of trips taken to Missouri basin streams above Fort Peck Dam by outfitters in the 1989 floating/fishing season.

River	Number of Trips	Percentage of total trips
Headwaters Subbasin		
Madison River	3,842	42.7%
Gallatin River	825	9.2%
Jefferson River	404	4.5%
Big Hole River	1,488	16.5%
Beaverhead River	641	7.1%
Ruby River	221	2.5%
Red Rock River	11	0.1%
East Gallatin River	4	—
		82.6%
Upper Missouri Subbasin		
Missouri River - Three Forks to Holter Dam	237	2.6%
Missouri River - Holter Dam to Great Falls	942	10.5%
Smith River	200	2.2%
Dearborn River	13	0.1%
Sixteen Mile Creek	12	0.1%
		15.5%
Middle Missouri Subbasin		
Missouri River below Great Falls	138	1.5%
Judith Headwaters	4	—
Other Missouri basin streams	11	0.1%
TOTAL	8,993	99.7%

NOTES: Other rivers included Sheep Creek (8 trips) and Willow Creek (3 trips)
Percentages do not total 100 due to rounding.
Source: Economic Consultants Northwest 1991a

Table 4-45. Effects of drought and decreased streamflows on outfitting business during 1988 and 1989

Effect	Increased	Decreased	No Effect	Total No. of Respondents
Number of trips taken	3%	57%	40%	99
Length of floating season	8%	62%	30%	99
Number of clients served	17%	46%	38%	101

Note: Percentages may not total 100 due to rounding.
Source: Economic Consultants Northwest 1991a

University of Montana (Yuan et al. 1989). Thus, the total economic impact in 1989 was $32.7 million.

The majority of economic impacts to Montana from guiding services on the Missouri River are realized from nonresident clients. Approximately 93 percent of the parties guided on these trips are nonresident. Moreover, it is estimated that each nonresident client spends approximately twice as much as a resident client on such items as lodging, gifts, sport licenses, and other miscellaneous costs. Of the $32.7 million in economic impact to the basin, approximately 95.5 percent, or $31.2 million, is attributable to out-of-state clients.

HEADWATERS SUBBASIN

Several headwater rivers, the Madison, Gallatin, Big Hole, Jefferson, and Beaverhead, received a high proportion of the total reported visits to the Missouri basin streams (DNRC 1990b). Between 8 and 15 percent of Montana residents visited these rivers. While these rivers received mostly local use, many people from other parts of the state and from out of state also visited them. Tributary rivers—the Ruby, Wise, Boulder, and Red Rock—are used primarily by local residents, with a small percentage coming from outside the subbasin (see Table 4-46).

DFWP estimated annual angler use on Montana waters from 1982 to 1986. Rivers and streams in the Headwaters Subbasin during 1985 had a total of 349,820 angler days of use, representing 29.3 percent of the total 1,193,000 angler days statewide. An angler day is one fisherman fishing one body of water for any length of time on one day. Map 4-7 shows that the Headwaters Subbasin receives the most angler use of any subbasin in Montana. Map 4-8 shows angler use, selected recreation sites, and estimated nonangler use on selected streams in the Headwaters Subbasin. Table 4-47 lists angler use on selected reservoirs in this subbasin.

GALLATIN RIVER DRAINAGE

The Gallatin River is popular for fishing, floating, and other recreational uses. The reach extending from Spanish Creek to the East Gallatin River averaged 28,408 angler days a year between 1982 and 1986. The lower reach from the East Gallatin to the Missouri averaged 13,439 angler days per year during this same period, while the upper reach above Spanish Creek averaged 14,619. Proximity to Bozeman and the high quality fishery on some segments of the river contribute to this high angler use. Other area streams with moderate angler use are the East Gallatin River with 7,629 angler days per year (1982-1986), Hyalite Creek with 2,800, and Bridger Creek with 1,546. Rates of angler use on tributaries are low or unknown (Appendix H).

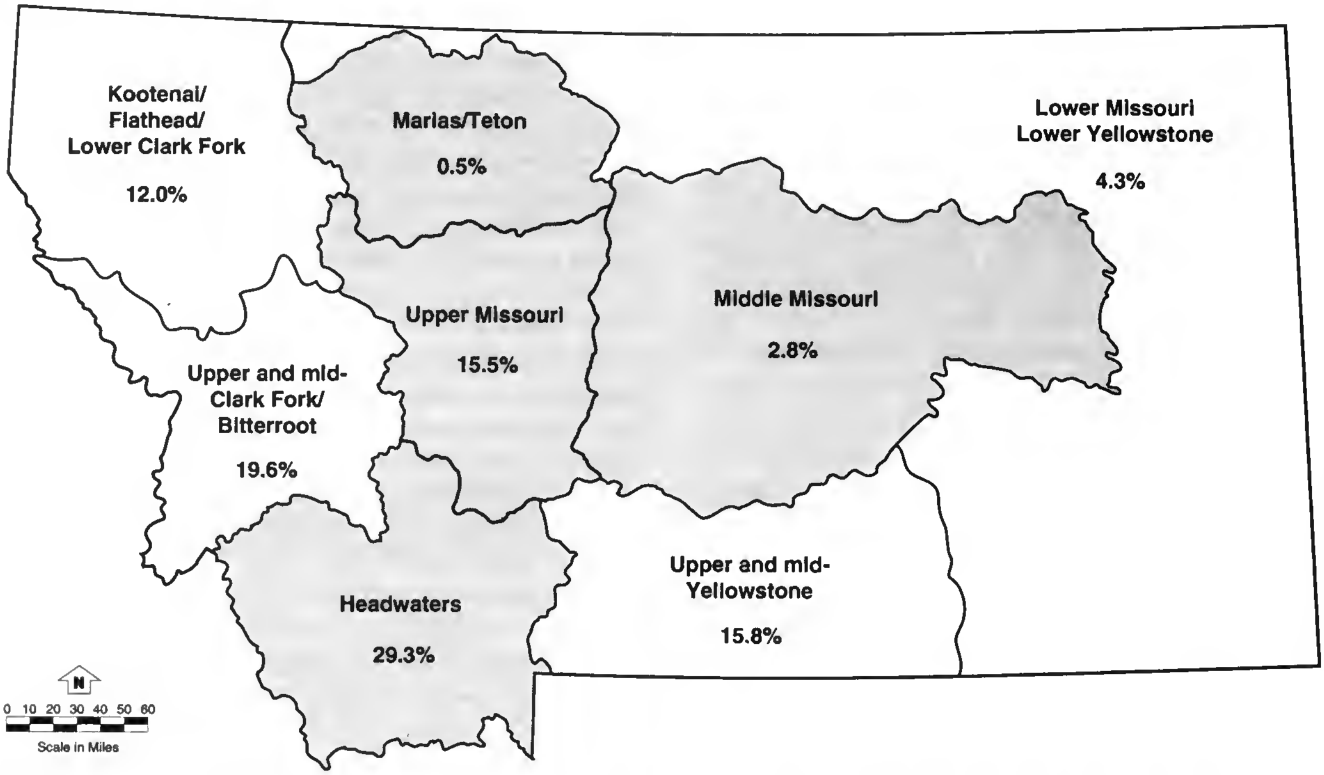
The primary activity on upper and middle reaches of the Gallatin is whitewater floating. On the lower Gallatin and East Gallatin, boating is a secondary

Table 4-46. Use of Headwaters Subbasin streams by Montana residents and nonresident anglers

River drainages	Residents of Headwaters Subbasin	Residents of Upper Missouri Subbasin	Residents of Middle Missouri Subbasin	Residents of remainder of state	Combined statewide total	Nonresident anglers
	(Percentage of population visiting Headwaters Subbasin drainages in 1989)					
Big Hole	32%	7%	4%	10%	11%	13%
Wise	14%	3%	1%	3%	4%	1%
Gallatin	36%	10%	10%	11%	13%	13%
Jefferson	32%	9%	5%	6%	9%	7%
Boulder	11%	7%	4%	6%	6%	4%
Madison	43%	12%	9%	11%	15%	24%
Beaverhead	22%	4%	5%	6%	8%	13%
Red Rock	6%	2%	1%	3%	3%	7%
Ruby	16%	1%	2%	3%	4%	3%

Notes: Column percents will not total 100 because respondents could answer more than one item.
Subbasin boundaries used in the survey differed slightly from those in this EIS.
Source: DNRC 1990b

Map 4-7. Fishing use of Montana river subbasins



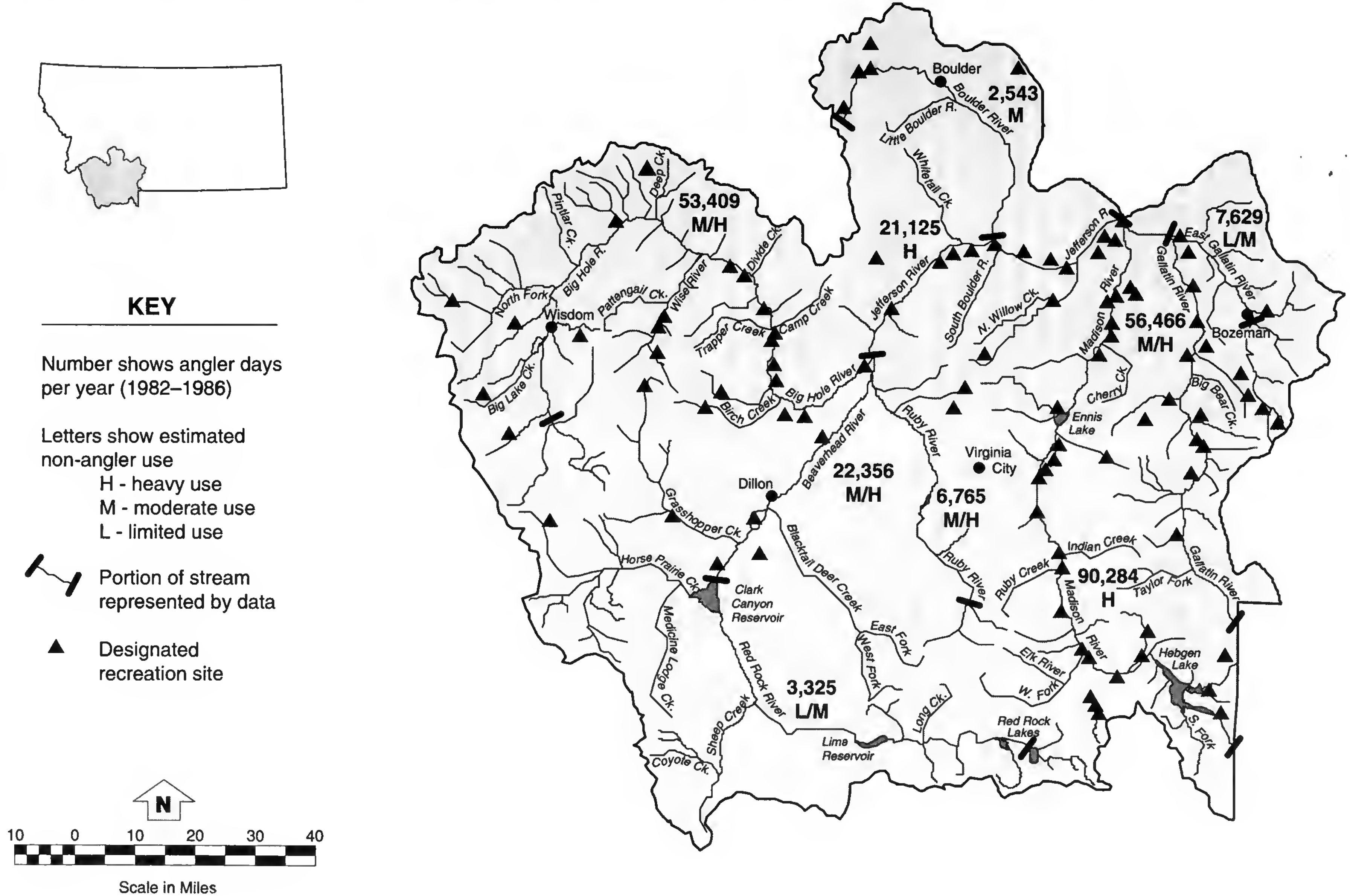
Notes:
Numbers shown are the percentage of total statewide fishing days occurring in each river subbasin determined during the 1985 DFWP fisheries survey.
Upper Missouri subbasin includes the main stem and tributaries from the Sun to the Marias.
Percentages may not total 100 due to rounding.
Source: DFWP 1989

Table 4-47. Angler use of reservoirs and lakes in the Headwaters Subbasin from 1982 to 1986

		Annual Angler Days[a]				
	(n)	1982-1983	1983-1984	1984-1985	1985-1986	Avg. 1982-1986
Clark Canyon Reservoir	(n=4)	58,311	28,880	38,256	35,900	40,337
Quake Lake	(n=4)	1,239	1,508	5,055	2,138	2,485
Ennis (Meadow) Lake	(n=4)	5,364	5,632	3,601	2,842	4,360
Hebgen Lake	(n=4)	49,282	52,848	35,476	44,630	45,559
Hyalite Reservoir	(n=4)	4,328	4,304	2,522	2,294	3,362
Lima Reservoir	(n=0)	b	b	b	b	0
Lower Red Rock Lake	(n=2)	50	b	85	b	68
Ruby River Reservoir	(n=4)	2,813	8,894	1,781	2,528	4,004
Upper Red Rock Lake	(n=1)	b	b	85	b	85
Willow Creek Reservoir	(n=4)	5,689	18,665	7,748	6,405	9,627

n = number of years out of four with reported fishing pressure
[a] Angler day = one fisherman fishing one body of water for any length of time on one day
[b] No data available
Source: DFWP 1989.

Map 4-8. Recreation use and designated recreation sites on selected rivers and streams in the Headwaters Subbasin



See Appendix H for a comprehensive listing of recreation information on basin streams.

activity. Low summertime flows and numerous logjams on the Gallatin below the canyon restrict floating on this reach (Vincent 1990).

Several tributaries in this drainage receive high to moderate levels of recreational use. These include Sourdough, Hyalite, and Cottonwood creeks south of Bozeman, the South Fork of the West Fork of the Gallatin (near Big Sky), and the Taylor Fork of the Gallatin River.

Madison River Drainage

The Madison River has a national reputation as a high quality trout fishery and receives high angler use. The reach from Hebgen Dam to Ennis Lake experienced an average of 40,636 angler days each year from 1982 to 1986. The reach from Ennis Lake to the mouth also has high use, averaging 36,742 angler days per year, while the reach above Hebgen Dam averages 12,906 angler days per year. Shore fishing is the primary recreation on the Madison and its tributaries. The Madison is used for boat fishing from a few miles downstream of Quake Lake to Ennis Lake (Appendix H).

Several tributaries of the Madison experience moderate angler use: the South Fork of the Madison with 2,600 angler days per year; the West Fork with 1,154; and Duck Creek with 1,504. Other tributaries have either low or unreported angler use.

Water in Ennis Lake warmed by the sun makes the river segment below the lake popular with summer recreationists (Fischer 1986). The Madison River below Ennis Lake passes through Beartrap Canyon in the Lee Metcalf Wilderness, where large rapids provide whitewater boating for rafts and kayaks. The Madison below Hot Springs Creek provides more relaxed floating and inner-tubing opportunities.

Opportunities for shoreline recreation are found throughout the Madison drainage. Eighteen developed recreation sites are located along the Madison below Quake Lake. Other developed recreation sites which are scattered along tributaries have moderate or low use.

The Jefferson/Boulder River Drainage

Angler use in the Jefferson/Boulder River drainage ranges from 21,125 angler days per year (1982 to 1986) on the Jefferson to low on tributaries such as the South Boulder River, Whitetail Creek, and North and South Willow creeks. The Boulder River and Willow Creek have moderate angler use, with 2,543 angler days per year on the Boulder and 2,942 on Willow Creek (see Appendix H).

Primary recreational activities include shore fishing throughout the drainage and boat fishing and floating on the Jefferson River. During summer, low flow conditions typically occur from the Parrot Canal diversion to below the Waterloo bridge on the Jefferson River (Rehwinkel 1990). These low flows limit floating and boat fishing. Floating is a secondary activity on the Boulder River.

Shoreline recreation is a primary activity along the Jefferson River and the Boulder River from its headwaters to Bison Creek. These two rivers have 10 of the 11 developed recreation sites, with 7 on the Jefferson and 3 on the upper reach of the Boulder. Shoreline recreation also occurs along North and South Willow creeks on National Forest land.

Big Hole River Drainage

The Big Hole River is very popular with Montana residents and is nationally known for its fishery. Angler use is dispersed throughout the drainage, but heaviest use occurs on the Big Hole below Pintlar Creek. From 1982 through 1985, the middle reach of the Big Hole between Pintlar Creek and Divide Creek averaged 23,502 angler days per year, and the reach from Divide Creek to the mouth averaged 21,005. The upper reach of the Big Hole, with 8,902 angler days, and Wise River with 3,001, show moderate levels of angler use. Most tributaries receive low angler use (Appendix H).

Shore fishing is the primary activity within this drainage. Boat fishing occurs only on the Big Hole and Wise rivers and a few tributaries. The Big Hole can be floated as far up as Jackson, but the most heavily floated segment is from Divide to Glen (Fischer 1986). Reaches of the Big Hole above Wisdom and from the Glen bridge to the mouth typically have low summer flows that limit floating (Oswald 1990).

Over half of the developed recreation sites in the drainage are along the Big Hole and Wise rivers. These two rivers have 16 sites—12 on the Big Hole and 4 on Wise River. Twelve other recreation sites are scattered among nine tributaries.

This drainage abounds with opportunities for shoreline activities such as picnicking, tent and car camping, and hiking. Concentrated use occurs along

the Big Hole and Wise rivers. Tributaries with high recreation use are Canyon, Wyman, Birch, and Seymour creeks and the upper reaches of Trapper Creek. Other tributaries in the Big Hole drainage have moderate to low use.

Ruby River Drainage

Angler use on the Ruby River is moderate, averaging 5,725 angler days per year below Ruby Reservoir and 1,040 days per year above it. Mill and Warm Springs creeks have low angler use. Angler use on other streams in the drainage is unknown. Boat fishing and floating are secondary uses on the Ruby, with most floating between Sheridan and Twin Bridges (Fischer 1986). Summer flows can be too low to float. Other streams in the drainage usually are not boated.

Shoreline use is high on the upper Ruby and Cottonwood, Mill, and Warm Springs creeks. Other streams have moderate to low use. Mill Creek has the most developed recreation sites (four) of any stream in the drainage. Cottonwood Creek and the lower Ruby each have one recreation site.

Red Rock/Beaverhead River Drainage

Fishing is the primary recreation in this drainage. The Beaverhead River had a yearly average of 22,356 angler days from 1982 to 1986. A popular reach for boat fishing and floating extends from Clark Canyon Dam to Barretts Dam near Dillon (Oswald 1990). Summer water levels vary with releases from Clark Canyon Dam (Fischer 1986). Clark Canyon Reservoir on the Beaverhead River sustains the highest angler use of any reservoir or lake in this drainage, with an average of 40,337 days per year (Table 4-47). Other streams with moderate angler use are: Red Rock River from Lima Dam to Clark Canyon Reservoir with 2,928 angler days per year; Grasshopper Creek with 2,440; Bloody Dick Creek with 2,404; Blacktail Deer Creek with 1,956; and Poindexter Slough with 1,459. Angler use on other streams is low or unreported.

Low angler use occurs on tributaries to Upper and Lower Red Rock lakes. Some floating occurs on Red Rock Creek, Red Rock River, lower Grasshopper Creek, Blacktail Deer Creek, and Poindexter Slough. Other streams are usually not boated.

Shoreline use is moderate or high on the Beaverhead and Red Rock rivers; Big Sheep, Bloody Dick, Red Rock, Grasshopper, and Horse Prairie creeks; Poindexter Slough; and Blacktail Deer Creek and its forks. Most developed recreation sites are located along the Beaverhead River and Grasshopper Creek.

Upper Missouri Subbasin

The Missouri River corridor from Three Forks to Great Falls receives a high proportion of reported visits to Missouri basin rivers and reservoirs (DNRC 1990b). Approximately 11 percent of state residents visit the Missouri River segment from Three Forks to Canyon Ferry, 17 percent visit Canyon Ferry Reservoir, 15 percent visit Hauser and Holter reservoirs, and 11 percent visit the segment from Holter Reservoir to Great Falls. Canyon Ferry, Hauser, and Holter reservoirs receive substantial use both from local residents and out-of-basin residents, giving them a regional if not statewide importance. Use is mostly from local people on the two segments of the Missouri above and below these reservoirs and on the Dearborn, Smith, and Sun rivers (see Table 4-48).

Map 4-9 shows angler use, selected recreation sites, and estimated nonangler use levels on selected streams in the Upper Missouri Subbasin. Table 4-49 lists angler use on selected reservoirs in this subbasin.

Angler use in the Upper Missouri Subbasin is significant, totaling 184,731 days during 1985. This represents 15.5 percent of the total 1,193,000 days of statewide use (see Map 4-7).

Missouri River Drainage - Three Forks to Holter Dam

The Missouri River from Three Forks to Holter Dam sustains high angler use. From Three Forks to Canyon Ferry Dam, angler use averaged 11,162 days per year from 1982 to 1986. This reach provides numerous opportunities for boat and shore fishing, floating, and shoreline recreation. For the same period, the segment from Canyon Ferry Dam to Hauser Dam averaged 8,784 angler days per year, while the reach from Hauser to Holter Dam averaged 15,656 angler days per year.

Canyon Ferry Reservoir, with 804,500 visitors in 1986, is the most heavily used recreation area in Montana, providing numerous opportunities for water-related recreation throughout the year. The reservoir has the highest reported angler use of all Missouri basin reservoirs and lakes, with a yearly average of 82,980 angler days between 1982 and 1986. Recreation facilities at Canyon Ferry include

Table 4-48. Use of Upper Missouri Subbasin rivers and reservoirs by Montana resident and nonresident anglers

	(Percentage of population visiting Upper Missouri Subbasin drainages in 1989)					
Drainage or reservoir	Residents of Headwaters Subbasin	Residents of Upper Missouri Subbasin	Residents of Middle Missouri Subbasin	Residents of remainder of state	Combined statewide total	Nonresident anglers
Missouri—Three Forks to Canyon Ferry	23%	26%	5%	8%	11%	9%
Canyon Ferry Reservoir	30%	38%	8%	12%	17%	8%
Hauser and Holter Reservoirs	16%	49%	10%	10%	15%	8%
Missouri—Holter Reservoir to Great Falls	6%	47%	9%	5%	11%	5%
Dearborn	2%	20%	3%	1%	4%	2%
Smith	3%	16%	3%	3%	5%	5%
Sun	3%	16%	9%	3%	6%	1%
Belt Creek	1%	22%	4%	2%	4%	2%
Missouri—Great Falls to Fort Benton	4%	18%	10%	4%	7%	4%

Column percentages will not total 100 because respondents could answer more than one item.
Subbasin boundaries used in the survey differed slightly from those in this EIS.
Source: DNRC 1990b

12 developed campgrounds, four day-use only sites, and seven boat ramps. Approximately 35,000 acres of open water are used for boating, waterskiing, fishing, sailing, and wind surfing. About 265 cabins and year-round residences occupy parts of the shoreline (DFWP 1989).

Low reservoir levels from 1987 through 1990 have affected recreation at Canyon Ferry Reservoir. In the spring of 1989, the surface water level was more than 20 feet below the normal operating elevation of 3,797 feet. Boat access was difficult because some ramps did not reach the water. Water surface reached a 30-year low level in March 1989 at 3,774 feet—23 feet below full pool. Most boat ramps on Canyon Ferry are unusable below 3,777 feet (Campbell 1990). Low water also caused problems for private cabin owners when docks became unusable. Exposure of rocks and sand bars created nuisances and hazards for motor boats and waterskiers.

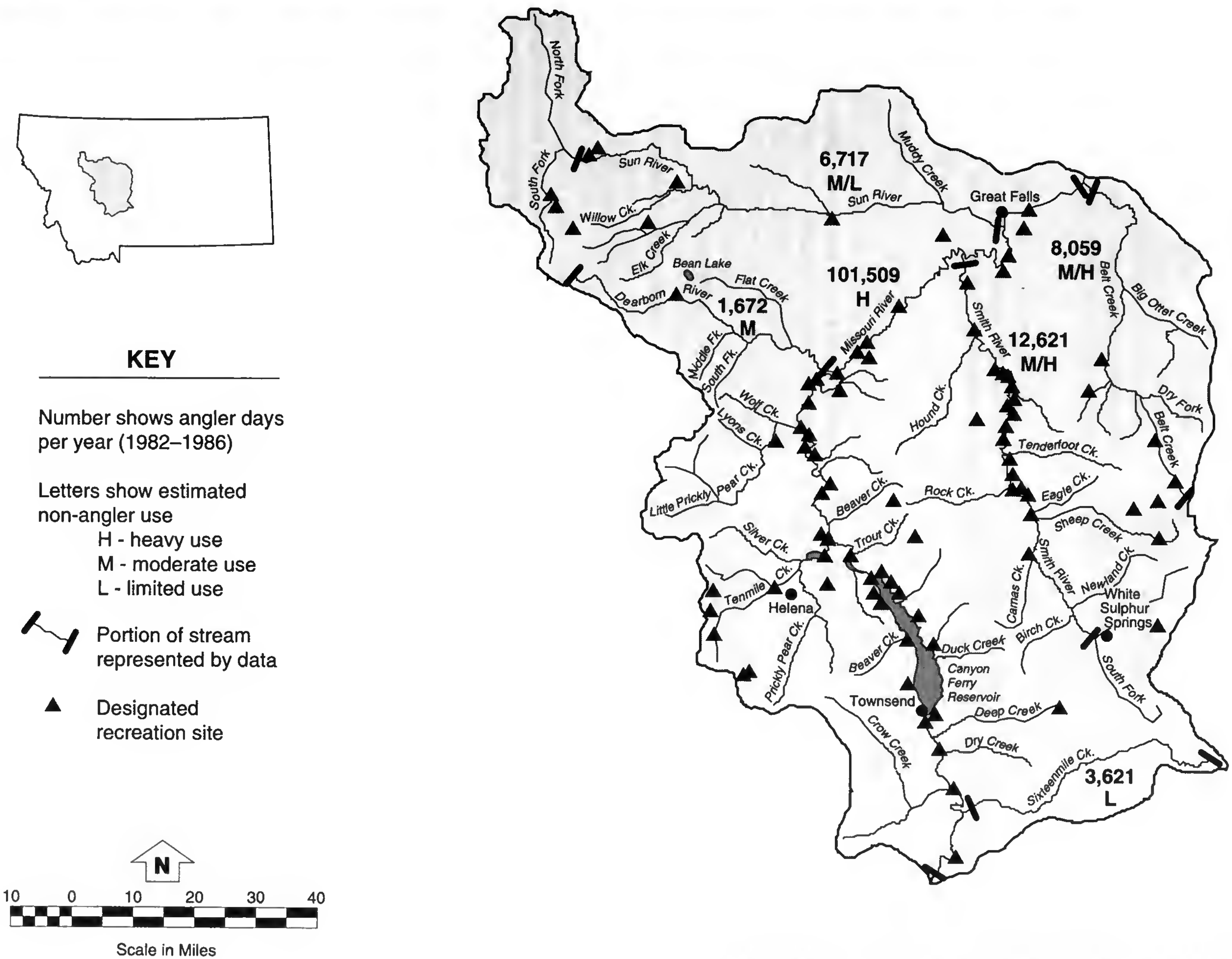
Hauser Reservoir also is important for recreation. Angler use averaged 28,307 days per year between 1982 and 1986. Five recreation sites are located along this impounded 15.5-mile reach of the river. The 3.5-mile flowing stretch of the Missouri River below Hauser Dam is important for fishing, floating, and hiking. Eagle watching is popular in the late fall between Hauser and Canyon Ferry dams. Fishing is the primary activity on this segment.

Holter Reservoir provides numerous opportunities for water-related recreation. Six public campgrounds and a private boat club are located along this reservoir. Holter Reservoir has the second highest reported angler use for reservoirs and lakes in the Missouri basin, with an average of 74,864 days per year (Table 4-49).

MPC estimated that 116,000 visitors used Hauser Reservoir recreation sites during the summer of 1982, with fishing and relaxing as the most popular activities (McCool 1982; Western Analysis 1982). Hauser, Holter, and Canyon Ferry reservoirs receive primarily local use. Canyon Ferry Reservoir also receives substantial use from surrounding counties.

Missouri River tributaries also are used for fishing and shoreline recreation. Moderate amounts of angler use occur on Sixteenmile, Crow, Dry, Beaver,

Map 4-9. Recreation use and designated recreation sites on selected rivers and streams in the Upper Missouri Subbasin



See Appendix H for a comprehensive listing of recreation information on basin streams.

Table 4-49. Angler use of reservoirs and lakes in the Upper Missouri Subbasin from 1982 to 1986

	(n)	Annual Angler Days[a] 1982-1983	1983-1984	1984-1985	1985-1986	Avg. 1982-1986
Bean Lake	(n=4)	5,183	10,404	8,181	5,090	7,215
Canyon Ferry	(n=4)	110,689	79,207	65,771	76,254	82,980
Hauser Lake	(n=4)	40,225	23,677	26,145	23,180	28,307
Holter Lake	(n=4)	86,636	68,903	68,217	75,699	74,864
Lake Helena	(n=4)	3,103	1,766	1,261	3,416	2,387
Lake Sutherlin	(n=0)	b	b	b	b	0
Toston Reservoir	(n=1)	b	b	b	197	197

n = number of years out of four with reported fishing pressure
[a] Angler day = one fisherman fishing one body of water for any length of time on one day
[b] No data available
Source: DFWP 1989

Prickly Pear, and Trout creeks (Appendix H). Other tributaries to this reach of the Missouri have low or unreported levels of fishing.

The Missouri River corridor has most of the developed recreation sites in this area, but some tributaries also have sites: Deep Creek with two developed sites, Tenmile Creek with three, Trout Creek with one, and Beaver Creek with two. Most of these sites are on National Forest land.

Missouri River Drainage - Holter Dam to Belt Creek

The Missouri River from Holter Dam to the Cascade bridge had the highest reported angler use of any stream reach in the basin between 1982 and 1986 (DFWP 1989), averaging 53,477 days per year. Proximity to both Great Falls and Helena and an excellent fishery contribute to this high use. The reach from the Cascade bridge to Morony Dam also received high angler use, averaging 21,214 days per year (Appendix H).

Fishing and floating are primary activities on this heavily used stretch of the Missouri River. About 15 recreation sites provide opportunities for shoreline recreation and access to the river between Holter Dam and Great Falls. Several of these sites are located along the Missouri River Recreation Road, extending from south of Wolf Creek to Hardy.

Tributaries to this segment of the Missouri River—Little Prickly Pear, Wolf, Canyon, and Lyons creeks—have moderate to low angler use. MPC studies (Western Analysis 1982; Wirth Environmental Services 1983) show that shore fishing, bird hunting, deer hunting, and floating are popular activities from Holter Reservoir to Fort Peck Reservoir. Activities were dispersed along the river with some concentrated use near Morony Dam.

Dearborn River Drainage

Angler use on the Dearborn River is moderate, averaging 1,672 days per year between 1982 and 1986. The Dearborn River provides opportunities for boating and floating, with the 19-mile stretch from the U.S. Highway 287 bridge to the Missouri River most popular. By midsummer of most years, low water makes most of the stream unsuitable for floating (Fischer 1986). One developed recreation site is located on National Forest land on the upper Dearborn.

Bean Lake sustains moderate angler use, averaging 7,215 days per year between 1982 and 1986. One recreation site provides opportunities for boating, fishing, picnicking, and camping.

Smith River Drainage

Angler use on the Smith River is moderate, averaging 8,080 days per year above Hound Creek and 4,541 below. The Smith River is one of Montana's more popular rivers, with floating and fishing the most important recreational uses. The most popular stretch includes the Smith River canyon from Camp Baker to Eden bridge. The number of floaters has

varied from 854 in 1985 to 2,654 in 1990 (Table 4-50). Because of a steady increase in floating, DFWP is implementing a registration and fee system in 1991. The duration of the float season varies from year to year depending on snowpack, rainfall, irrigation, and releases from storage, most notably Newlan Creek Reservoir (Table 4-50).

The lower Smith River is used primarily for day floats between the Eden and Truly bridges, with some picnicking and fishing at the Truly bridge fishing access site.

Smith River tributaries having moderate angler use include Rock, Sheep, and Hound creeks (Appendix H). Other tributaries have low angler use. One recreation site is located on Sheep Creek.

Sun River Drainage

The Sun River receives moderate angler use, with an average of 4,262 days per year above Muddy Creek and 2,455 below. Floating and shore fishing are important activities on the Sun River (Appendix H). There is one developed recreation site. Floating begins below Gibson Reservoir and downstream of the diversion dam, with whitewater conditions for the first 25 miles when flows are high (Fischer 1986). The river is used for flatwater floating below the U.S. Highway 287 bridge near Augusta. Floating on the Sun is affected by diversions between Gibson Dam and Fort Shaw.

Tributaries are used for fishing and shoreline recreation. Angler use on Elk Creek is moderate, averaging 1,469 days per year. Other tributaries have low or unreported angler use (Appendix H). Five developed recreation sites are located on National Forest land along Sun River tributaries.

Table 4-50. Smith River floating

	1984	1985	1986	1987	1988	1989	1990
Number of registered floaters	1,971	854	1,962	1,242	1,462	2,395	2,654
Date when river bacame generally unfloatable[a]	July 15	June 15	August 1	June 17	June 6	June 25	July 9

[a] 100 cfs at Camp Baker
Source: Heagney 1990, Cheek 1989

Belt Creek Drainage

Belt Creek supports an average of 8,059 angler days per year. Shore fishing and floating are primary activities (Appendix H). Above Monarch, floating is a secondary activity. Shoreline recreation occurs at moderate to high levels along Belt Creek. Recreation sites are most common above the Riceville bridge. Shoreline recreation is common on the Dry Fork of Belt Creek and in Tillinghast, Pilgrim, Logging, and Big and Little Otter creeks.

Marias/Teton Subbasin

Angler use is generally low in this subbasin (Map 4-7), except on the Marias River, Tiber Reservoir, and Lake Frances. Map 4-10 and Appendix H show angler use, selected recreation sites, and estimated nonangler use levels on streams in the Marias/Teton Subbasin. Table 4-51 lists angler use on reservoirs in this subbasin. The Marias and Teton rivers receive primarily local use (Table 4-52).

Marias River Drainage

The Marias River supports moderate angler use, averaging 3,156 days per year between 1982 and 1986 below Tiber Dam and 1,924 days above. Shore fishing is a primary activity on the Marias, followed by floating (Appendix H).

Recreational use is high around Tiber Reservoir and moderate on the river. One developed recreation site is located below Tiber Dam. Tiber Reservoir, covering approximately 22,180 acres, averaged 13,199 angler days per year between 1982 and 1986.

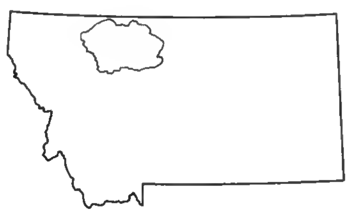
Lake Frances, an off-stream storage reservoir near Valier, averaged 10,718 angler days per year between 1982 and 1986. Besides boating and fishing, the reservoir also provides opportunities for wind surfing and shoreline activities.

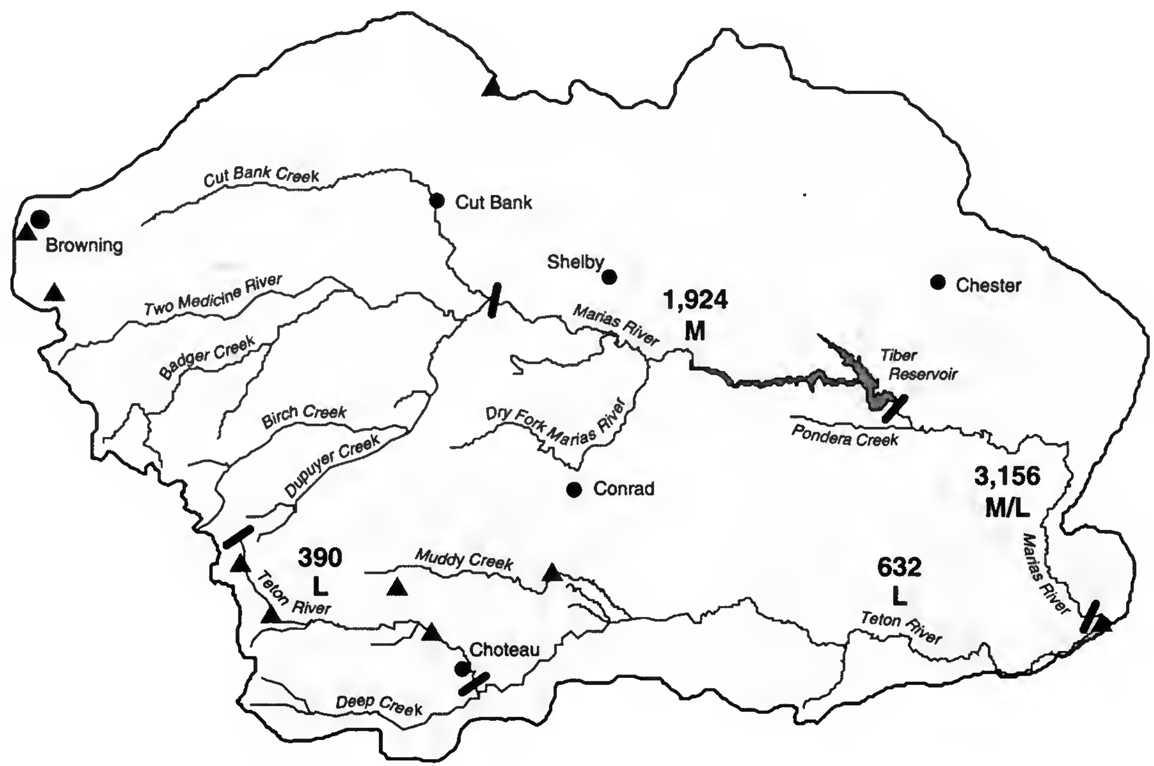
Tributaries are used for shore fishing and shoreline recreation. A few people float on Birch Creek from Swift Dam to the Marias River, Two Medicine River, and Badger and Cut Bank creeks (Appendix H). Use levels are moderate to low on all tributaries. Angler use is low on area tributaries. Dry Fork, Marias, Laughlin Coulee, Timber Coulee, and Whitetail Creek have undocumented levels of use.

Teton River Drainage

Recreational use in this drainage is very low. Angler use on the Teton River averaged 390 days per

Map 4-10. Recreation use and designated recreation sites on selected rivers and streams in the Marias/Teton Subbasin





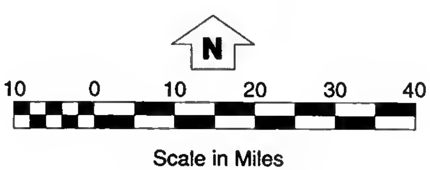
KEY

Number shows angler days per year (1982–1986)

Letters show estimated non-angler use
- H - heavy use
- M - moderate use
- L - limited use

Portion of stream represented by data

▲ Designated recreation site



See Appendix H for a comprehensive listing of recreation information on basin streams.

Table 4-51. Angler use of reservoirs and lakes in the Marias/Teton Subbasin from 1982 to 1986

	(n)	Annual Angler Days[a] 1982-1983	1983-1984	1984-1985	1985-1986	Avg. 1982-1986
Tiber Reservoir	(n=4)	8,591	14,837	13,215	16,152	13,199
Lake Frances	(n=4)	9,026	5,038	8,211	20,597	10,718

n = number of years out of four with reported fishing pressure
[a] Angler day = one fisherman fishing one body of water for any length of time on one day
Source: DFWP 1989

Table 4-52. Use of Marias/Teton Subbasin rivers and reservoirs by Montana resident and nonresident anglers

	(Percentage of population visiting Missouri basin drainages in 1989) Residents of Headwaters Subbasin	Residents of Upper Missouri Subbasin	Residents of Middle Missouri Subbasin	Residents of remainder of state	Combined statewide total	Nonresident anglers
Marias	2%	6%	17%	2%	5%	NR
Teton	4%	4%	8%	1%	3%	3%

Source: DNRC 1990
NR - Not reported
Column percentages will not total 100 because respondents could answer more than one item.
Subbasin boundaries used in the survey differed slightly from those in this EIS.

year above Choteau and 632 days per year below Choteau between 1982 and 1986. Tributaries in this drainage have unknown levels of angler use. The South Fork and North Fork of Deep Creek are used for shoreline recreation. Limited floating occurs on the Teton.

Middle Missouri Subbasin

Angler use on Middle Missouri Subbasin rivers and streams is substantially lower than in the Headwaters and Upper Missouri subbasins, probably because of the greater distance of these streams from major population centers. Angler use for this subbasin in 1985 totaled 33,558 days, representing 2.8 percent of the state total (Map 4-7). Map 4-11 shows angler use, selected recreation sites, and estimated nonangler use levels on streams in the Middle Missouri Subbasin. Table 4-53 lists angler use on selected reservoirs in this subbasin.

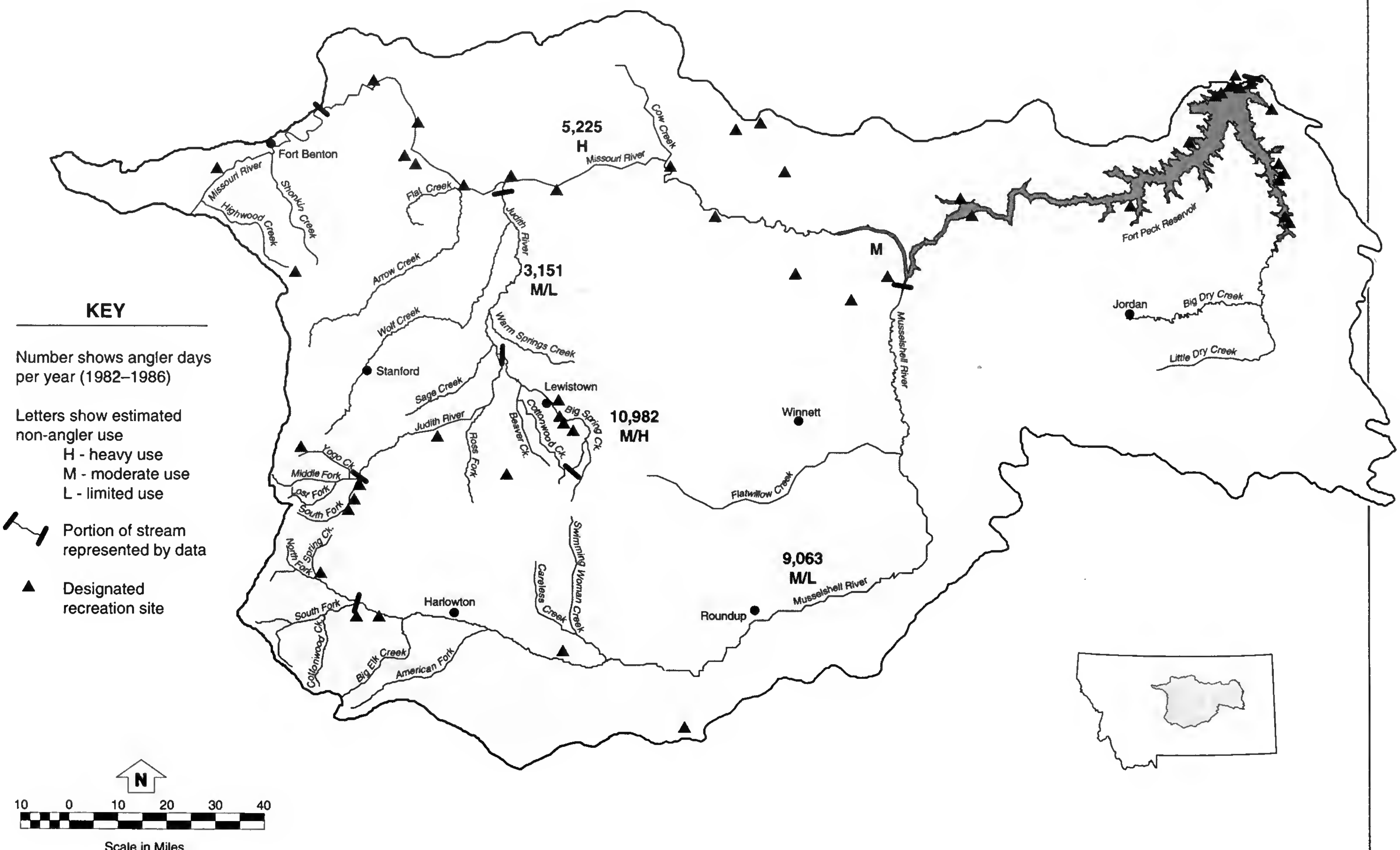
Survey results indicate that the Judith and Musselshell rivers and Big Spring Creek receive mostly local use (DNRC 1990b). Reported visits are low compared to other basin rivers (Table 4-54). The Missouri River below Fort Benton receives state-wide use.

Missouri River Drainage - Belt Creek to Fort Peck Reservoir

Angler use is moderate on the Missouri River below Great Falls. The reach from Morony Dam to the Marias River averaged 7,640 angler days per year between 1982 and 1986. From the Marias River to Fort Peck Dam, 5,225 angler days per year were reported. Boat fishing, shore fishing, and floating are popular activities, and use is high above the Fred Robinson bridge (Appendix H).

The stretch of the Missouri between Fort Benton and Fred Robinson Bridge is a designated Wild and Scenic river. Boating use was estimated at 3,068 individual boaters in 1989, and shoreline visitors were estimated at 15,771 (Biggs 1990). There are 13 recreation sites and 6 designated access points along this portion of

Map 4-11. Recreation use and designated recreation sites on selected rivers and streams in the Middle Missouri Subbasin



See Appendix H for a comprehensive listing of recreation information on basin streams.

Table 4-53. Angler use of reservoirs and lakes in the Middle Missouri Subbasin from 1982 to 1986

	(n)	Annual Angler Days[a] 1982-1983	1983-1984	1984-1985	1985-1986	Avg. 1982-1986
Ackley Lake	(n=4)	9,329	3,875	2,981	121	4,077
Bair Reservoir	(n=3)	1,948	765	709	b	1,141
Deadmans Basin Reservoir	(n=4)	19,962	20,978	16,174	11,952	17,267
Fort Peck Reservoir	(n=4)	22,722	41,329	23,226	37,411	31,172
Martinsdale Reservoir	(n=4)	11,089	11,757	15,767	10,665	12,320
Petrolia Reservoir	(n=4)	3,220	410	1,653	105	1,347

n = number of years out of four with reported fishing pressure
[a] Angler day = one fisherman fishing one body of water for any length of time on one day
[b] No data available
Source: DFWP 1989

Table 4-54. Use of Middle Missouri Subbasin rivers and reservoirs by Montana resident and nonresident anglers.

(Percentage of population visiting Missouri basin drainages in 1989)

Drainage	Residents of Headwaters Subbasin	Residents of Upper Missouri Subbasin	Residents of Middle Missouri Subbasin	Residents of remainder of state	Combined statewide total	Nonresident anglers
Missouri below Fort Benton	15%	11%	NR	6%	7%	8%
Judith	2%	3%	8%	2%	3%	2%
Big Spring Creek	3%	1%	8%	2%	3%	1%
Musselshell	3%	3%	10%	7%	7%	2%
Fort Peck	5%	5%	NR	9%	6%	2%

Source: DNRC 1990b
NR = not reported
Column percents will not total 100 because respondents could answer more than one item.
Subbasin boundaries used in the survey differed slightly from those in this EIS.

the Missouri. Five-year trends in use levels from 1985 through 1989 indicate a 3.8 percent increase in boating visitor days, a 13.3 percent increase in bankside visitor days, and a combined visitor day increase of 9.2 percent. As defined by BLM, a visitor day is use of an area for 12 hours by one or more persons. Of the registered groups visiting Fort Benton Visitor Center, 31 percent were from Montana, 51 percent from other states, 15 percent from Canada, and 3 percent from countries other than Canada.

Highwood and Shonkin creeks, two tributaries of the Missouri near Fort Benton, have moderate levels of angler use. Highwood Creek has 1,211 angler days per year, and Shonkin Creek has 1,642.

Judith River Drainage

Several streams in this drainage sustain moderate levels of angler use in spite of their distance from larger population centers. Of these, Big Spring Creek near Lewistown supports the highest angler use, averaging 8,196 days per year from 1982 to 1986 above Cottonwood Creek and 2,786 below it. Angler use is moderate on the Judith River above Plum Creek, on Warm Springs Creek, and on the South

Fork of the Judith. Other tributaries have low or unreported angler use (Appendix H).

The Judith River from Danvers bridge to the Anderson bridge is popular for floating and fishing. This reach is fed by Warm Spring and Big Spring creeks.

Shoreline recreation is moderate to low throughout this drainage, except for Big Spring Creek above Lewistown, where use is high. Four developed recreation sites are located along Big Spring Creek. Other recreation sites are located along Warm Springs Creek and the upper Judith River.

Musselshell River Drainage

The Musselshell River has moderate angler use, providing one of the few opportunities for river-based recreation in central Montana. Angler use averaged 5,194 days per year between 1982 and 1986 above Lavina and 3,869 below. Shore fishing is the primary activity on the Musselshell, and other shoreline recreation and floating are secondary activities (Appendix H). Use is moderate for the upper reach above the diversion to Deadmans Basin and low below it. Eight developed recreation sites are scattered along the river.

Several reservoirs are used for fishing and other water-related recreation (Table 4-53). These include Bair Reservoir on the North Fork of the Musselshell River, Martinsdale Reservoir near Martinsdale, Deadmans Basin Reservoir near Shawmut, Ackley Lake west of Lewistown, and Petrolia Reservoir on Flatwillow Creek. Deadmans Basin and Martinsdale reservoirs have developed facilities for shoreline activities, including several summer cabins at Deadmans Basin.

Tributaries are used for shore fishing and shoreline recreation. Angler use is low with the exception of American Fork Creek south of Harlowton. This stream averaged 1,106 days per year between 1982 and 1986. Nonangler recreation use is high for Spring and Flatwillow creeks, and moderate for the North Fork of the Musselshell and the upper reaches of Careless and Swimming Woman creeks.

Fort Peck Reservoir, Little Dry Creek, and Big Dry Creek

Fort Peck Reservoir, with over 245,000 acres of the reservoir and along approximately 1,540 miles of shoreline, has moderate levels of angler use, averaging 31,172 days per year from 1982 to 1986. Shoreline activities are concentrated at the 18 recreation sites.

Recent dry years, combined with water releases by the U.S. Army Corps of Engineers, have lowered reservoir levels 30 to 40 feet below the normal operating pool elevation of 2,246 feet (Sheffield 1990). Boat access to the reservoir was difficult or impossible until most ramps were extended or relocated. Low water also has exposed large mud flats and created underwater hazards for boats.

No water-related recreation is reported for Little Dry and Big Dry creeks, two tributaries to Fort Peck Reservoir east of Jordan.

HYDROPOWER

Eleven hydroelectric facilities in the Missouri River are owned and operated by four different entities as shown in Table 4-55 and on Map 4-12.

The total generating capacity of all types of facilities in the state is approximately 4,800 megawatts (MW) (DOE 1989a). Approximately 50 percent of this capacity is from hydropower, with 566.1 MW produced by facilities on the Missouri and Madison rivers.

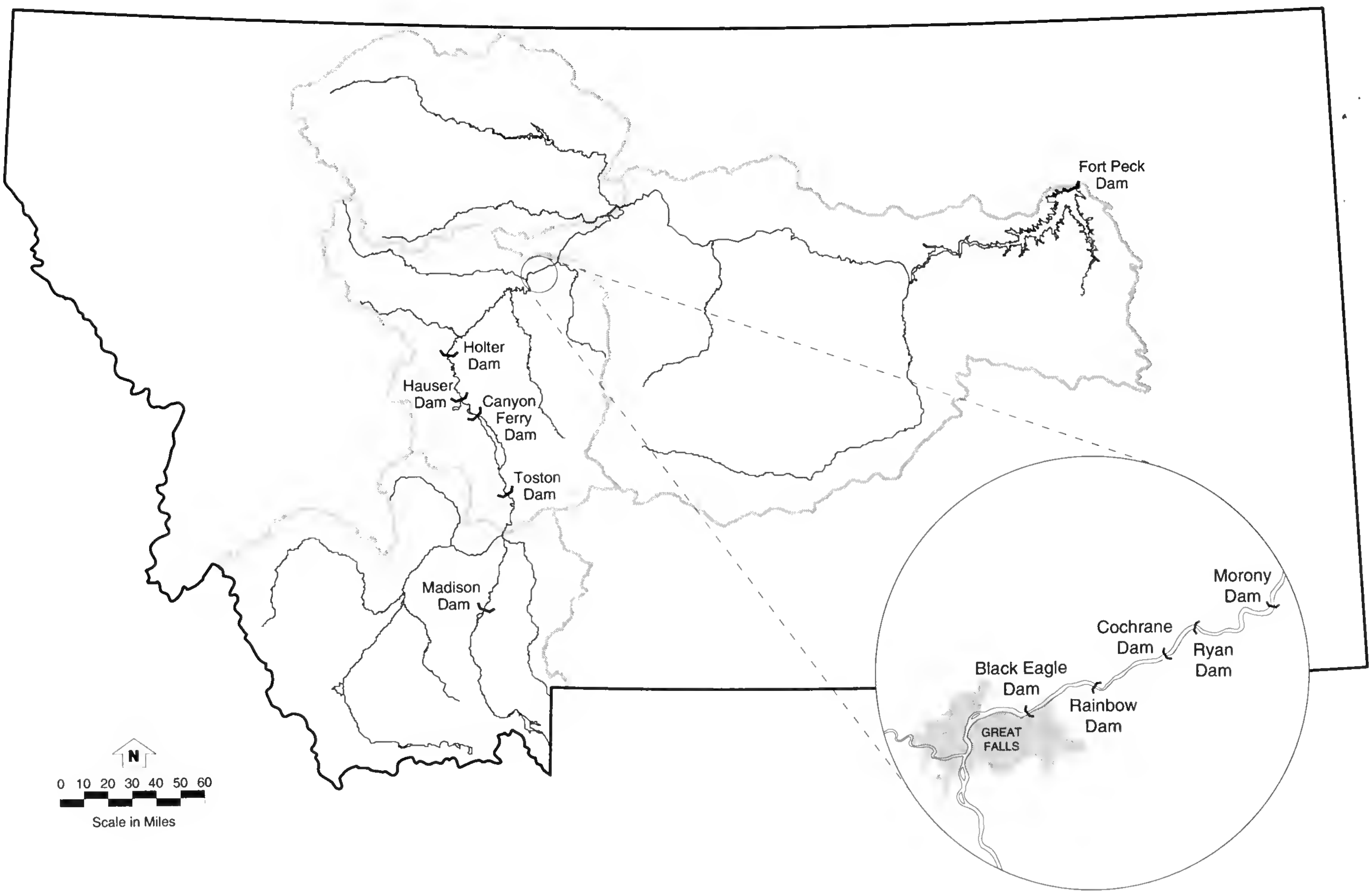
Montana is a net exporter of electricity. Annual electricity consumption in the state averaged 12,000 gigawatt hours for the years 1985 through 1987, whereas electricity production for the same period

Table 4-55. Missouri basin hydroelectric plants in Montana.

Facility	Owner	Units	Generating Capability[a] (MW)
Black Eagle	MPC	3	18
Broadwater	DNRC	1	10[b]
Canyon Ferry	BUREC	3	59.1
Cochrane	MPC	2	50
Fort Peck	U.S. Army Corps of Engineers	5	213
Hauser	MPC	6	16.5
Holter	MPC	4	49
Madison	MPC	4	8.5
Morony	MPC	2	47
Rainbow	MPC	8	35
Ryan	MPC	6	60

[a] Capability reflects actual generating experience and may be greater or less than the manufacturer's nameplate capacity rating.
[b] Nameplate capacity. The Broadwater plant has not operated long enough to establish its capability.

Map 4-12. Major hydroelectric facilities in the Missouri basin



averaged 20,700 gigawatt hours. About 9,936 Gigawatt hours, or 48 percent of the total electricity generated in Montana, was produced at hydroelectric facilities. Nationwide, only 11.5 percent of all electricity produced is from hydropower.

Electric utility rates in Montana are among the lowest in the nation, primarily because of low cost hydropower. Average residential rates in Montana are 5.5 cents per kilowatt hour while the U.S. average is 7.4 cents (DOE 1988). Average commercial rates in Montana are 4.9 cents per kilowatt hour while the U.S. average is 7.1 cents. Average industrial rates in Montana are 2.9 cents per kilowatt hour while the U.S. average is 4.9 cents. Only Washington and Idaho have lower average rates in all three categories. Oregon and Tennessee have lower residential rates but higher commercial and industrial rates.

There is potential for additional hydroelectric production in the Missouri basin. At this time, however, most of the emphasis is on upgrading existing facilities.

Federal Relicensing of MPC's Dams

The Montana Power Company owns and operates nine dams on the Madison and Missouri rivers, with a total storage capacity of about 581,000 acre-feet. Hebgen Dam on the upper Madison is used to provide stored water to MPC's downstream hydropower facilities. The other eight dams—Madison, Hauser, Holter, Black Eagle, Ryan, Cochrane, Rainbow, and Morony—are equipped to generate hydroelectricity. They have a collective capacity of 286 MW and generate an annual average of about 217 MW.

MPC operates these facilities under a 50-year license from the Federal Energy Regulatory Commission (FERC), and the license is due to expire in 1994. MPC must submit an application for a new license by 1992. In this application, MPC plans to propose that several of the dams be repaired, upgraded, and expanded (Table 4-56). Upgrading the generation facilities would provide about 63 additional MW of capacity.

Under the FERC relicensing process, MPC must consult with state resource agencies to identify information needs and the necessary studies to obtain information. MPC has completed the first round of agency consultation and is working on a number of studies to identify the effects of the proposed modifications. Studies are under way on a number of recreation, fisheries, wildlife, and economic issues. Results from these studies will be included in MPC's application to FERC.

One possible result of the proposed upgrades and expansions may be that the facilities' water use will change. A change in the type or quantity of use may require MPC to file for new water rights. Table 4-56 indicates the changes foreseen at MPC's facilities.

Table 4-56. Planned modifications to MPC's Missouri basin hydroelectric facilities.

HEBGEN:	No modifications to the facilities or to historical release patterns.
MADISON:	Rehabilitate and replace existing equipment to increase power production capability with the same hydraulic capacity. No changes in historical release patterns.
HAUSER:	Rehabilitate and replace equipment to increase power production capability with the same hydraulic capacity. No changes in historical release patterns.
HOLTER:	No modifications to the facilities or to historical release patterns.
BLACK EAGLE:	First, raise tailwater elevation to eliminate existing cavitation problem and increase generation capacity up to rated value. Second, increase hydraulic capacity. No real changes in historical release patterns.
RAINBOW:	Rehabilitate existing equipment, reconstruct power generation facilities, and increase hydraulic capacity. No real changes in historical release patterns.
COCHRANE:	Raise dam to produce more head. This would be done in conjunction with tailrace modifications at Rainbow Dam. Modify operations to allow for load shaping at Ryan Dam.
RYAN:	Expand facilities to increase hydraulic capacity and power generation capabilities. Modify operations to increase load shaping capabilities.
MORONY:	No physical modifications but some operational changes to accommodate modifications at Cochrane and Ryan dams.

Source: MPC 1989

SOCIOECONOMICS

EMPLOYMENT

The relative importance of the various sectors of Montana's economy has changed markedly over the last four decades (Figure 4-16). Relative employment in the service, finance, and other nonagriculture proprietor sector increased more than 260 percent between 1950 and 1987, accounting for 41 percent of Montana's total work force in 1987. The relative employment in government (schools and local, state, and federal agencies), wholesale and retail trade, and transportation sectors has gradually shifted over the last 40 years, but these sectors together continue to comprise approximately 44 percent of Montana employment. The most dramatic trend is the relative decrease in the minerals, manufacturing, and construction sector and in the agricultural sector, both of which have shrunk almost 65 percent (Figure 4-16). Farmers and ranchers have continued to increase their farm productivity, while reducing their employment levels. The service industry has expanded and now provides the largest portion of employment in both the state and in the Missouri River basin.

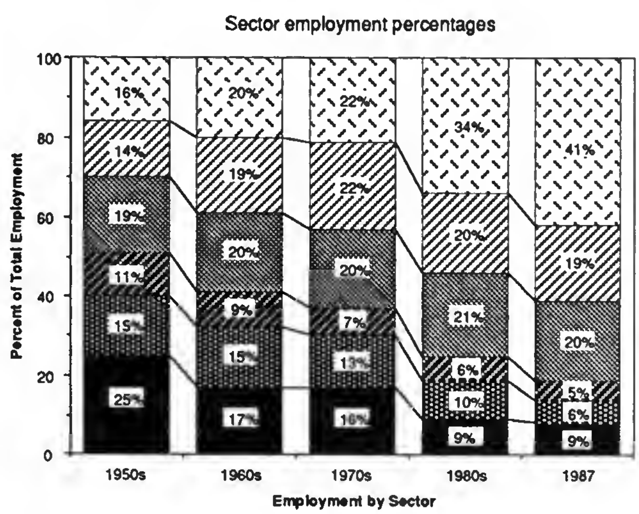
The employment trends in the Missouri River basin over the last 20 years are only slightly less dramatic than statewide trends over the past 40 years (Figure 4-17). The service, finance, and other nonagriculture proprietor sector increased by 39 percent between the early 1970s and mid-1980s to 32 percent of the total. Over the same period, both the agriculture sector and the manufacturing, minerals, and construction sector dropped, declining about 30 percent (Figure 4-17). The other major economic sectors changed very little in employment.

INCOME

Over the past four decades, Montana's income trends have generally followed its employment trends. Relative service, finance, and other nonagriculture proprietor income has increased almost 260 percent, while relative agricultural earnings have declined more than 89 percent (Figure 4-18). Increased farm productivity and slowing demand for agricultural products have depressed agricultural income. The service, finance, and other nonagriculture proprietor sector is the largest source of income in both the state and the Missouri basin.

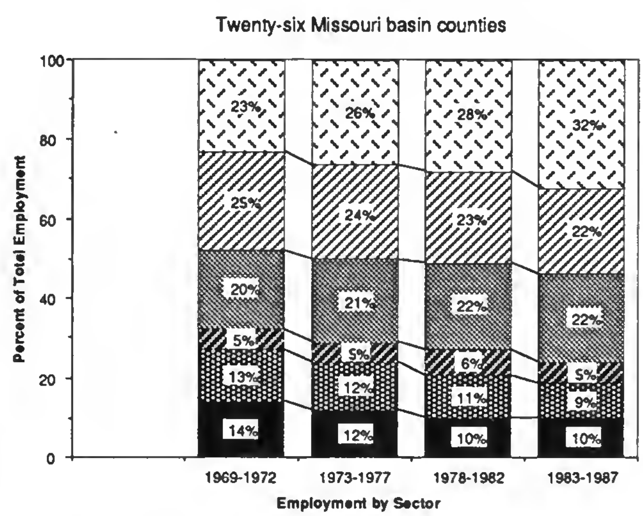
Relative income in the Missouri River basin is dominated by the service sector, which has grown steadily over the past 20 years to provide over 50 percent of basin income (Figure 4-19). During the same period, agricultural income has contracted sharply, becoming the smallest sector, providing 3 percent of basin income.

Figure 4-16. Montana employment trends



Source: Martin, 1989.

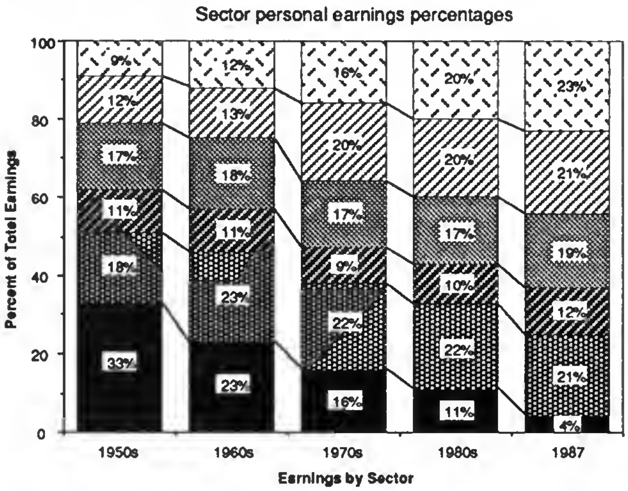
Figure 4-17. Missouri basin employment trends



Source: U.S. Bureau of Economic Analysis, 1989.

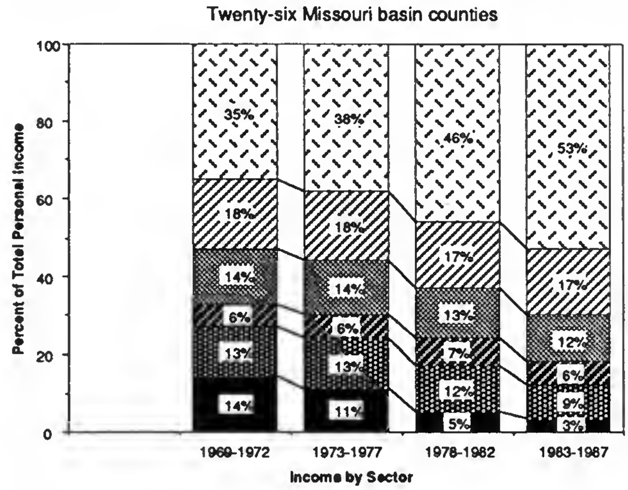
Agriculture
Manufacturing, minerals, & construction
Transportation & utilities
Wholesale & retail trade
Government
Services, finance, & other nonagriculture proprietor

Figure 4-18. Montana earnings trends



Source: Martin, 1989.

Figure 4-19. Missouri basin personal income trends



Source: U.S. Bureau of Economic Analysis, 1989.

Agriculture
Manufacturing, minerals, & construction
Transportation & utilities
Wholesale & retail trade
Government
Services, finance, & other nonagriculture proprietor

TAXATION

The sectors of Montana's economy are taxed in a different manner and at varying rates. Agricultural land is taxed at 30 percent of its production capacity. In 1987, irrigated land in Montana was assessed at an average of $9.40 per acre, 38 percent more per acre than dry cropland and almost nine times the per-acre taxable value of rangeland at $1.06 (Montana Department of Revenue 1988). Improvements to agricultural property such as outbuildings and wells are taxed at 3.088 percent of market value. Agriculture represented about 14 percent of total statewide taxable value in 1987, or about $80 million (Martin 1989). Tables 4-58 through 4-61 show subbasin tax valuation and receipts.

Public utility property such as Montana Power Company's nine storage and hydroelectric dams in the Missouri River basin is centrally assessed by the Montana Department of Revenue at 12 percent of market value. The facility taxable value was about $13.5 million in 1988, on which MPC paid $1,617,508 in property taxes (Kent 1991).

The following sections describe agriculture's role in basin and subbasin economies. The values of water-based recreation and hydropower production are discussed in their respective sections.

MISSOURI RIVER BASIN AGRICULTURE ECONOMY

Farm related employment in the 26 counties that comprise the Missouri River basin accounted for about 10 percent of total basin employment in 1987, and was slightly higher than the statewide average of 9 percent (Table 4-57). Basin farm employment increased over 6 percent between 1977 and 1987, while statewide farm employment increased 8 percent during the same period. Basin farm employment accounted for 46 percent of total statewide farm employment.

Farm income (including transfer payments) totaled approximately 6 percent of all 1987 income in the basin, a slightly higher portion than the 1987 statewide figure of 5 percent. Farm income figures more than doubled between the years of 1977 and 1987. Although some of this increase is due to a doubling of government farm payments over this 10-year period, the very large increase suggests that other temporary factors, including drought, depressed farm income during the 1977 reporting period.

Agricultural sales in the Missouri River basin totaled $788 million in 1987, or approximately 54

Table 4-57. Economic baseline data—Missouri River basin above Fort Peck Dam

Category	Montana 1977[a]	Montana 1987	Montana Percent Change	Missouri River Basin 1977	Missouri River Basin 1987	Missouri River Basin Percent Change	Missouri River Basin Percent of Montana 1977	Missouri River Basin Percent of Montana 1987
Total Employment	366,201	407,289	11%	162,289	175,195	8%	44%	43%
Farm Employment	35,275	38,096	8%	16,379	17,433	6%	46%	46%
Percent of Total	10%	9%		10%	10%			
Total Personal Income ($000)	$8,665,770	$9,946,430	15%	$3,809,708	$4,285,266	12%	44%	43%
Farm Income ($000)	$208,184	$493,678	137%	$102,403	$266,741	160%	49%	54%
Percent of Total	2%	5%		3%	6%			
Total Ag Sales ($000)	$1,809,107	$1,471,313	-19%	$ 970,012	$ 787,781	-19%	54%	54%
Livestock Sales ($000)	$976,422	$884,173	-9%	$ 461,288	$ 434,462	-6%	47%	49%
Percent of Total	54%	60%		48%	55%			
Crop Sales ($000)	$832,685	$587,140	-30%	$ 508,720	$ 353,319	-31%	61%	60%
Percent of Total	46%	40%		52%	45%			

[a] 1977 dollars are adjusted to 1987 dollar equivalents.
Sources:
U.S. Bureau of Economic Analysis, Regional Economic Information System, Unpublished computerized data, Washington, D.C., 1989
Montana Department of Revenue, Unpublished Computerized Data, January 1989
Montana Department of Commerce, Unpublished Data, April 1990

percent of Montana's total agricultural sales (Table 4-57). Livestock sales in the basin comprised 55 percent of total basin agricultural sales, while crop sales totaled $353 million and made up 45 percent of the basin's sales.

Agricultural economies in the Missouri River basin are dominated by the Marias/Teton and Middle Missouri subbasins. The Upper Missouri and Headwaters subbasins are similar to statewide patterns deriving less than 7 percent of their employment and less than 4 percent of their income from the agricultural sector. A detailed discussion of the economies of the four subbasins is presented in the following sections.

Headwaters Subbasin

Nearly one in three jobs within the Missouri River basin are located in the Headwaters Subbasin; however, the economy of the subbasin is less dependent on agricultural production than is the basin as a whole. In 1987, farm employment in the Headwaters Subbasin totaled 3,640, or 7 percent of total employment (Table 4-58). Farm employment in the subbasin increased by 20 percent between 1977 and 1987.

Between 1977 and 1987, total personal income in the Headwaters Subbasin increased at a slightly faster rate than the total basin increase and the statewide increase. In 1987, farm income in the subbasin was approximately 3 percent of total personal income. Agricultural sales, which totaled $165.6 million in 1987, were related mainly to livestock sales. Cash receipts from crop sales amounted to $42.2 million or 26 percent of total agricultural sales in the subbasin. The taxable valuation of agricultural machinery and land was $19.1 million in 1988, and accounted for 12 percent of subbasin total taxable valuation.

Upper Missouri Subbasin

The importance of agriculture in the Upper Missouri Subbasin is much less prevalent than in the other three subbasins within the Missouri River basin. In 1987, agricultural employment totaled 2,840 and accounted for 4 percent of the total jobs in the subbasin (Table 4-59). Similarly, farm income in 1987 was $29.9 million and totaled only 2 percent of all income in the basin. Cash receipts from agricultural sales were principally related to the sale of livestock products and totaled $112.3 million in 1987. In 1988, taxable valuation on agricultural

Table 4-58. Economic baseline data—Headwaters Subbasin of the Missouri River basin

Category	Totals 1977[a]	Totals 1987	Percent Change	Percent of Missouri River Basin 1977	Percent of Missouri River Basin 1987
Economic Data:					
Total Employment	44,473	52,807	19%	27%	31%
Farm Employment	3,039	3,640	20%	19%	21%
Percent of Total	7%	7%			
Total Personal Income ($000)	$1,069,763	$1,270,602	18%	28%	30%
Farm Income ($000)	$19,612	$43,325	121%	19%	16%
Percent of Total	2%	3%			
Total Ag Sales ($000)	$148,988	$165,647	11%	15%	21%
Livestock Sales ($000)	$111,887	$123,407	10%	24%	28%
Percent of Total	75%	74%			
Crop Sales ($000)	$37,100	$42,240	14%	7%	12%
Percent of Total	25%	26%			
Tax Data:		1988		1988	
Subbasin Taxable Valuation ($000)		$156,813		24%	
Ag Taxable Valuation ($000)		$19,073		12%	
Percent of Total		12.2%			
Mill Levy		283.41			

[a] 1977 dollars are adjusted to 1987 dollar equivalents.
Sources:
U.S. Bureau of Economic Analysis, Regional Economic Information System, Unpublished computerized data, Washington, D.C., 1989
Montana Department of Revenue, Unpublished Computerized Data, January 1989
Montana Department of Commerce, Unpublished Data, April 1990

Table 4-59. Economic baseline data—Upper Missouri Subbasin of the Missouri River basin

Category	Totals 1977[a]	Totals 1987	Percent Change	Percent of Missouri River Basin 1977	Percent of Missouri River Basin 1987
Economic Data:					
Total Employment	68,135	73,327	8%	42%	42%
Farm Employment	2,387	2,840	19%	15%	16%
Percent of Total	4%	4%			
Total Personal Income ($000)	$1,643,822	$1,761,056	7%	43%	41%
Farm Income ($000)	$19,387	$29,877	54%	19%	11%
Percent of Total	1%	2%			
Total Ag Sales ($000)	$140,491	$112,298	-20%	14%	14%
Livestock Sales ($000)	$93,497	$77,571	-17%	20%	18%
Percent of Total	67%	69%			
Crop Sales ($000)	$46,994	$34,727	-26%	9%	10%
Percent of Total	33%	31%			
Tax Data:		1988		1988	
Subbasin Taxable Valuation ($000)		$175,828		26%	
Ag Taxable Valuation ($000)		$ 17,036		11%	
Percent of Total		10%			
Mill Levy		254.26			

[a] 1977 dollars are adjusted to 1987 dollar equivalents.
Sources:
U.S. Bureau of Economic Analysis, Regional Economic Information System, Unpublished computerized data, Washington, D.C., 1989
Montana Department of Revenue, Unpublished Computerized Data, January 1989
Montana Department of Commerce, Unpublished Data, April 1990

machinery and land was $17.0 million and accounted for 10 percent of the total valuation in the subbasin.

Marias/Teton Subbasin

The economy of the Marias/Teton Subbasin is strongly related to agricultural production (Table 4-60). In 1987, 20 percent of total employment and 16 percent of total income in the subbasin were related to agriculture. Between 1977 and 1987, total subbasin employment declined by 4 percent while farm employment remained steady.

Total personal income increased, primarily due to increased farm income. Total agricultural sales in the subbasin decreased from $375.2 million in 1977 to $276.1 million by 1987 (Table 4-60). All of the decrease in agricultural sales was attributable to reduced crop sales. In 1988, taxable valuation in the Marias/Teton Subbasin totaled $175.4 million, with 39 percent of this total related to taxable valuation on agricultural land and machinery.

Middle Missouri Subbasin

The economy of the Middle Missouri Subbasin of the Missouri River basin is heavily dependent on agriculture. In 1987, approximately 25 percent of subbasin employment and 14 percent of total personal income were directly attributable to agriculture (Table 4-61). Approximately 29 percent of the Missouri River basin agricultural economy was related to farm and ranch activities in the Middle Missouri Subbasin. Cash receipts from livestock marketings made up approximately 61 percent of agricultural sales in the subbasin in 1987, while crop receipts totaled $91.6 million or 39 percent of agricultural sales. Slightly over 32 percent of the total taxable valuation in the subbasin is related to the valuation on agricultural land and machinery.

Table 4-60. Economic baseline data—Marias/Teton Subbasin of the Missouri River basin

Category	Totals 1977[a]	Totals 1987	Percent Change	Percent of Missouri River Basin 1977	Percent of Missouri River Basin 1987
Economic Data:					
Total Employment	28,162	27,173	-4%	17%	16%
Farm Employment	5,441	5,445	0%	34%	32%
Percent of Total	19.3%	20.0%			
Total Personal Income ($000)	$616,236	$708,257	15%	16%	17%
Farm Income ($000)	$30,068	$115,654	285%	34%	43%
Percent of Total	6%	16%			
Total Ag Sales ($000)	$375,241	$276,079	-26%	39%	35%
Livestock Sales ($000)	$81,295	$91,308	12%	18%	21%
Percent of Total	22%	33%			
Crop Sales ($000)	$293,945	$184,771	-37%	58%	52%
Percent of Total	78%	67%			
Tax Data:		1988		1988	
Subbasin Taxable Valuation ($000)		$175,357		26%	
Ag Taxable Valuation ($000)		$68,307		44%	
Percent of Total		39%			
Mill Levy		226.66			

[a] 1977 dollars are adjusted to 1987 dollar equivalents.

Sources:

U.S. Bureau of Economic Analysis, Regional Economic Information System, Unpublished computerized data, Washington, D.C., 1989

Montana Department of Revenue, Unpublished Computerized Data, January 1989

Montana Department of Commerce, Unpublished Data, April 1990

Table 4-61. Economic baseline data—Middle Missouri Subbasin of the Missouri River basin

Category	Totals 1977[a]	Totals 1987	Percent Change	Percent of Missouri River Basin 1977	Percent of Missouri River Basin 1987
Economic Data:					
Total Employment	22,059	21,888	-1%	13%	12%
Farm Employment	5,512	5,508	0%	34%	32%
Percent of Total	25%	25%			
Total Personal Income ($000)	$479,887	$545,351	14%	13%	13%
Farm Income ($000)	$28,336	$77,885	175%	28%	29%
Percent of Total	6%	14%			
Total Ag Sales ($000)	$305,290	$233,757	-23%	31%	30%
Livestock Sales ($000)	$174,609	$142,176	-19%	38%	33%
Percent of Total	57%	61%			
Crop Sales ($000)	$130,681	$91,581	-30%	26%	26%
Percent of Total	43%	39%			
Tax Data:		1988		1988	
Subbasin Taxable Valuation ($000)		$157,349		24%	
Ag Taxable Valuation ($000)		$50,603		33%	
Percent of Total		32%			
Mill Levy		208.88			

[a] 1977 dollars are adjusted to 1987 dollar equivalents.

Sources:

U.S. Bureau of Economic Analysis, Regional Economic Information System, Unpublished computerized data, Washington, D.C., 1989

Montana Department of Revenue, Unpublished Computerized Data, January 1989

Montana Department of Commerce, Unpublished Data, April 1990

CHAPTER FIVE

ALTERNATIVES CONSIDERED IN THIS EIS

INTRODUCTION

DNRC developed four hypothetical alternatives to help assess the environmental effects from granting or denying the proposed reservations. DNRC's intent in developing these alternatives was to illustrate the effects of the different water use emphases, encompassing a reasonable range of actions that could be taken by the Board. These alternatives do not limit the Board's discretion in approving, modifying, denying, or prioritizing the requests for reservations. The alternatives are intended only to illustrate the range of environmental effects and tradeoffs associated with reservations for irrigation, municipal and instream purposes, and the effect of the No Action Alternative (denial of all applications).

Each reservation application will require action on the part of the Board. The decisions by the Board will be based on the record developed through the hearings process. The EIS is expected to be a part of that record.

In developing the alternatives, DNRC took into account that the Board is required to establish priorities among the intended water uses. DNRC gave municipal reservations the highest priority under each alternative because of the importance of sufficient water supplies for communities and the relatively small amount of water needed. The priority of other uses was emphasized differently among alternatives. The alternatives developed by DNRC are described below and analyzed in Chapter Six.

CONSUMPTIVE USE ALTERNATIVE

This alternative emphasizes reservations for future irrigation and municipal use. The Consumptive Use Alternative is intended to reflect what would happen if the Board were to grant reservations primarily for irrigation and municipal use. All consumptive use reservations applied for would be granted under this alternative, including water for 212,209 acres of new irrigation. In cases where water is not always available for all requested reservations, municipalities would receive first preference, followed by irrigation projects. Any water remaining after satisfaction of municipal and irrigation reservations would be reserved for instream use. Table 5-1 identifies the reservations included in this alternative and their relative priority.

INSTREAM EMPHASIS ALTERNATIVE

This alternative emphasizes instream reservations for the protection of fish, wildlife, recreation, and water quality. As in all other alternatives, municipalities would be given first priority. Instream requests for fish, wildlife, recreation, and water quality protection would receive first priority where there is no municipal request and second priority where there is. Third priority would be given to reservations for irrigation projects that DNRC considers at least marginally feasible on an economic and financial basis with the remaining amount of water. The irrigation projects in this alternative would encompass 46,950 acres. Table 5-1 identifies the reservations included in this alternative and their relative priority.

COMBINATION ALTERNATIVE

The Combination Alternative places highest priority on municipal requests and second priority to irrigation projects that are at least marginally feasible. Instream requests would be given third priority except on those streams where there are no competing consumptive use applications, in which case instream requests would receive first priority. Table

5-1 lists projects included in this alternative and their relative priority. The Combination Alternative differs from the Consumptive Use Alternative in two ways. First, where DNRC determined that municipal requests would reserve more water than needed to serve future populations, the reservation was limited to the amount needed. Second, irrigation projects would have second priority where the following criteria could be met: (1) enough water is available; (2) soils are irrigable; (3) the projects have at least a 50 percent chance of being economically feasible, according to DNRC analysis; and (4) there would be no insurmountable conflicts with land uses such as residences, roads, or railroads. Under this alternative, water would be reserved to irrigate 133,294 acres.

NO ACTION/DENY ALTERNATIVE

The Board could deny all requested reservations. In Chapter Six, DNRC describes those trends that might occur through the year 2025 if no water is reserved for any purpose.

CONSIDERATIONS COMMON TO INSTREAM, CONSUMPTIVE USE, AND COMBINATION ALTERNATIVES

DNRC defined certain factors that would apply to all the alternatives.

1. Reservations must adhere to the statute requiring that instream reservations not exceed one-half the average recorded annual flow on gauged streams. Reservation requests in excess of this statutory limit were reduced to legal levels.

2. The concentration of arsenic in the Madison and Missouri rivers far exceeds the state instream water quality standard (discussed in Chapter Four). Few of the proposed consumptive use projects could be operated without violating this standard. However, DNRC did not exclude any projects from discussion on the basis of arsenic problems. If the Board grants consumptive use reservations that could cause violation of the instream arsenic standard, it could require that the projects involved be subject to compliance with certain conditions such as:

   a. In approving reservations for consumptive use, either the Board of Natural Resources and Conservation or the Board of Health and Environmental Sciences could require reservants to demonstrate that their projects would not violate water quality standards. This finding could be required for each project before it could be developed.
   b. Construction of water treatment facilities or other actions could be required to reduce arsenic contamination to compensate for any increased arsenic concentrations caused by the new consumptive uses.

3. Each reservant could be required to install a water measuring device. This could assist in managing water allocated for reservations.

Table 5-1. Reservation requests included under each alternative

HEADWATERS SUBBASIN

Gallatin River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Belgrade	Gallatin River/Wells	Municipal	3.6				
Bozeman	Sourdough Creek	Municipal	4,030 af				
GA-13	Well	Irrigation	1.34				
GA-14	Well	Irrigation	0.63				
GA-24	Well	Irrigation	1.84				
GA-40	Well	Irrigation	0.94				
GA-41	Well	Irrigation	1.26				
GA-44	Well	Irrigation	2.20				
GA-46	Well	Irrigation	1.26				
GA-79	Well	Irrigation	4.5				
GA-81	Well	Irrigation	3.5				
GA-92	Well	Irrigation	0.9				
GA-110	Well	Irrigation	1.6				
GA-124	Well	Irrigation	0.71				
GA-130	Well	Irrigation	2.1				
GA-143	Well	Irrigation	4.4				
GA-151	Well	Irrigation	0.5				
GA-35	Well	Irrigation	0.6				
DFWP	Baker Creek	Instream	14.0				
DFWP	Ben Hart Spring Creek	Instream	29.0				
DFWP	Big Bear Creek	Instream	2.0				
DFWP	Bridger Creek	Instream	18.3[a]				
DFWP	Cache Creek	Instream	2.6				
DFWP	East Fork Hyalite Creek	Instream	7.0				
DFWP	East Gallatin River #1	Instream	42.4[a]				
DFWP	East Gallatin River #2	Instream	90.0				

Gallatin River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	East Gallatin River #3	Instream	170.0				
DFWP	Gallatin River #1	Instream	170.0				
DFWP	Gallatin River #2	Instream	400.0				
DFWP	Gallatin River #3	Instream	533.5[a]				
DFWP	Hell Roaring Creek	Instream	16.0				
DFWP	Hyalite Creek #1	Instream	28.0				
DFWP	Hyalite Creek #2	Instream	16.0				
DFWP	Middle Fork of West Fork Gallatin River	Instream	3.0				
DFWP	Porcupine Creek	Instream	4.5				
DFWP	Reese Creek	Instream	5.0				
DFWP	Rocky Creek	Instream	51.0				
DFWP	Sourdough Creek	Instream	35.9				
DFWP	South Cottonwood Creek	Instream	14.0				
DFWP	South Fork Spanish Creek	Instream	15.0				
DFWP	South Fork of West Fork Gallatin River	Instream	5.0				
DFWP	Spanish Creek	Instream	70.0				
DFWP	Squaw Creek	Instream	12.0				
DFWP	Taylor Fork	Instream	36.0				
DFWP	Thompson Spring Creek	Instream	29.0				
DFWP	West Fork Gallatin River	Instream	26.0				
DFWP	West Fork Hyalite Creek	Instream	12.0				

GA = Gallatin County Conservation District

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Madison River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
West Yellowstone	Whiskey Spring	Municipal	3.5				
GA-201	Madison River	Irrigation	118.4				
DFWP	Antelope Creek	Instream	14.0				
DFWP	Beaver Creek	Instream	937.0				
DFWP	Black Sand Spring Creek	Instream	18.7				
DFWP	Blaine Spring Creek	Instream	23.0				
DFWP	Cabin Creek	Instream	585.0				
DFWP	Cherry Creek	Instream	15.0				
DFWP	Cougar Creek	Instream	24.0				
DFWP	Duck Creek	Instream	23.0				
DFWP	Elk River	Instream	28.0				
DFWP	Grayling Creek	Instream	34.0				
DFWP	Hot Springs Creek	Instream	5.5				
DFWP	Indian Creek	Instream	48.0				
DFWP	Jack Creek	Instream	24.0[a]				
DFWP	Madison River #1 above Hebgen Lake	Instream	245.0[a]				
DFWP	Madison River #2 above West Fork	Instream	502.5[a]				
DFWP	Madison River #3 above Ennis	Instream	716.0[a]				
DFWP	Madison River #4 above mouth	Instream	825.0[a]				
DFWP	Moore Creek	Instream	1.4				
DFWP	North Meadow Creek	Instream	18.0				
DFWP	O'Dell Spring Creek	Instream	98.0				

Madison River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	Red Canyon Creek	Instream	2.9				
DFWP	Ruby Creek	Instream	18.0				
DFWP	South Fork Madison River	Instream	92.0				
DFWP	Squaw Creek	Instream	14.0				
DFWP	Standard Creek	Instream	10.0				
DFWP	Trapper Creek	Instream	3.2				
DFWP	Watkins Creek	Instream	5.5				
DFWP	West Fork Madison River	Instream	957.0				

GA = Gallatin County Conservation District

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

a Instream flow requests that have been reduced to ½ the average annual flow

Jefferson River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Three Forks	Jefferson River/Well	Municipal	0.5	First	First	First	
JV-17	Boulder River/Wells	Irrigation	1.9	Second		Second	
JV-18	Boulder River/Wells	Irrigation	1.1	Second		Second	
JV-63	Boulder River/Wells	Irrigation	0.8	Second		Second	
JV-80	Boulder River/Wells	Irrigation	1.0	Second		Second	
JV-81	Boulder River/Wells	Irrigation	1.3	Second		Second	
BR-52	Jefferson River	Irrigation	0.7	Second		Second	
BR-101	Jefferson River	Irrigation	77.4	Second		Second	
GA-102	Jefferson River	Irrigation	2.3	Second		Second	
JV-25	Jefferson River	Irrigation	0.5	Second			
JV-55	Jefferson River	Irrigation	1.86	Second		Second	
JV-95	Jefferson River	Irrigation	14.4	Second			
JV-201	Jefferson River	Irrigation	80.3	Second			
JV-202	Jefferson River	Irrigation	88.9	Second			
JV-203	Jefferson River	Irrigation	35.8	Second			
JV-204	Jefferson River	Irrigation	7.4	Second			
DFWP	Boulder River #1 above High Ore Creek	Instream	20.0	Third	Second	Third	
DFWP	Boulder River #2 above Cold Springs	Instream	24.0	Third	Second	Third	
DFWP	Boulder River #3 above mouth	Instream	47.0	Third	Second	Third	
DFWP	Halfway Creek	Instream	1.9	Third	Second	Third	
DFWP	Hells Canyon Creek	Instream	3.6	Third	Second	Third	
DFWP	Jefferson River	Instream	1095.5[a]	Third	Second	Third	

Jefferson River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	Little Boulder River	Instream	7.0	Third	Second	Third	
DFWP	North Willow Creek	Instream	7.0	Third	Second	Third	
DFWP	South Boulder River	Instream	12.0	Third	Second	Third	
DFWP	South Willow Creek	Instream	14.0	Third	Second	Third	
DFWP	Whitetail Creek	Instream	3.0	Third	Second	Third	
DFWP	Willow Creek	Instream	14.0	Third	Second	Third	
DFWP	Willow Spring Creek	Instream	9.2	Third	Second	Third	

JV = Jefferson County Conservation District
BR = Broadwater County Conservation District

First priority of use
Second priority of use
Third priority of use
Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Big Hole River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	American Creek	Instream	2.8				
DFWP	Bear Creek	Instream	2.8				
BLM-Minimum Flows	Bear Creek	Instream	2.5				
BLM-Maximum Flows	Bear Creek	Instream	50.0				
DFWP	Big Hole River #1 above Pintlar Creek	Instream	160.0				
DFWP	Big Hole River #2 above old Divide Dam	Instream	800.0				
DFWP	Big Hole River #3 above mouth	Instream	573.0[a]				
DFWP	Big Lake Creek	Instream	4.7				
DFWP	Birch Creek	Instream	10.0				
DFWP	Bryant Creek	Instream	1.4				
DFWP	California Creek	Instream	14.0				
DFWP	Camp Creek	Instream	5.0				
BLM-Minimum Flows	Camp Creek	Instream	5.0				
BLM-Maximum Flows	Camp Creek	Instream	50.0				
DFWP	Canyon Creek	Instream	5.0				
BLM-Minimum Flows	Canyon Creek	Instream	5.0				
BLM-Maximum Flows	Canyon Creek	Instream	110.0				
DFWP	Corral Creek	Instream	1.0				
DFWP	Deep Creek	Instream	18.0				
BLM-Minimum Flows	Deep Creek	Instream	30.0				
BLM-Maximum Flows	Deep Creek	Instream	500.0				
DFWP	Delano Creek	Instream	0.3				
DFWP	Divide Creek	Instream	3.0				
DFWP	Fishtrap Creek	Instream	10.0				
DFWP	Francis Creek	Instream	4.0				
DFWP	French Creek	Instream	6.0				
DFWP	Governor Creek	Instream	4.0				
DFWP	Jacobsen Creek	Instream	14.0				
DFWP	Jerry Creek	Instream	7.0				
DFWP	Johnson Creek	Instream	13.0				
DFWP	Joseph Creek	Instream	5.0				
DFWP	LaMarche Creek	Instream	11.0				
DFWP	Miner Creek	Instream	9.0				
DFWP	Moose Creek	Instream	9.0				
BLM-Minimum Flows	Moose Creek	Instream	8.0				
BLM-Maximum Flows	Moose Creek	Instream	70.0				
DFWP	Mussigbrod Creek	Instream	10.0				
DFWP	North Fork Big Hole River	Instream	30.0				
DFWP	Oregon Creek	Instream	0.3				
DFWP	Pattengail Creek	Instream	12.0				
DFWP	Pintlar Creek	Instream	10.0				
DFWP	Rock Creek	Instream	5.0				
DFWP	Ruby Creek	Instream	4.0				
DFWP	Sevenmile Creek	Instream	1.8				
DFWP	Seymour Creek	Instream	13.0				
DFWP	Sixmile Creek	Instream	1.6				
DFWP	South Fork Big Hole River	Instream	22.0				
DFWP	Steel Creek	Instream	6.0				

First priority of use

Second priority of use

Third priority of use

Reservation is not included in this alternative

a Instream flow requests that have been reduced to ½ the average annual flow

Big Hole River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	Sullivan Creek	Instream	4.0				
DFWP	Swamp Creek	Instream	8.0				
DFWP	Tenmile Creek	Instream	3.8				
DFWP	Trail Creek	Instream	14.0				
DFWP	Trapper Creek	Instream	3.2				
DFWP	Twelvemile Creek	Instream	1.2				
DFWP	Warm Springs Creek	Instream	20.0				
DFWP	Willow Creek	Instream	16.0				
BLM-Minimum Flows	Willow Creek	Instream	12.0				
BLM-Maximum Flows	Willow Creek	Instream	130.0				
DFWP	Wise River	Instream	35.0				
DFWP	Wyman Creek	Instream	7.0				

Ruby River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	Coal Creek	Instream	3.6				
DFWP	Cottonwood Creek	Instream	4.0				
DFWP	East Fork Ruby River	Instream	3.0				
DFWP	Middle Fork Ruby River	Instream	5.0				
DFWP	Mill Creek	Instream	10.0				
DFWP	North Fork Greenhorn Creek	Instream	3.5				
BLM-Minimum Flows	North Fork Greenhorn Creek	Instream	3.5				
BLM-Maximum Flows	North Fork Greenhorn Creek	Instream	35.0				
DFWP	Ruby River #1 above Reservoir	Instream	90.0 [a]				
DFWP	Ruby River #2 above mouth	Instream	40.0				
DFWP	Warm Spring Creek	Instream	48.5				
DFWP	West Fork Ruby River	Instream	3.0				
DFWP	Wisconsin Creek	Instream	12.0				

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Beaverhead River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Dillon	Beaverhead River/Wells	Municipal	1.1				
DFWP	Bear Creek	Instream	8.5				
BLM-Minimum Flows	Bear Creek	Instream	6.0				
BLM-Maximum Flows	Bear Creek	Instream	50.0				
DFWP	Beaverhead R. #1 above Barrets Diversion Dam	Instream	200.0				
DFWP	Beaverhead River #2 above mouth	Instream	200.0				
DFWP	Big Sheep Creek	Instream	33.0[a]				
BLM-Minimum Flows	Big Sheep Creek	Instream	40.0				
BLM-Maximum Flows	Big Sheep Creek	Instream	300.0				
DFWP	Black Canyon Creek	Instream	2.5				
BLM-Minimum Flows	Black Canyon Creek	Instream	2.5				
BLM-Maximum Flows	Black Canyon Creek	Instream	35.0				
DFWP	Blacktail Deer Creek	Instream	27.0[a]				
DFWP	Bloody Dick Creek	Instream	20.0				
BLM-Minimum Flows	Bloody Dick Creek	Instream	20.0				
BLM-Maximum Flows	Bloody Dick Creek	Instream	270.0				
DFWP	Browns Canyon Creek	Instream	2.3				
DFWP	Cabin Creek	Instream	0.4				
BLM-Minimum Flows	Cabin Creek	Instream	1.0				
BLM-Maximum Flows	Cabin Creek	Instream	4.0				
DFWP	Corral Creek	Instream	6.0				
BLM-Minimum Flows	Corral Creek	Instream	2.5				
BLM-Maximum Flows	Corral Creek	Instream	20.0				
DFWP	Deadman Creek	Instream	4.5				
BLM-Minimum Flows	Deadman Creek	Instream	4.5				
BLM-Maximum Flows	Deadman Creek	Instream	50.0				

Beaverhead River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	East Fork Blacktail Deer Creek	Instream	18.0				
BLM-Minimum Flows	East Fork Blacktail Deer Creek	Instream	18.0				
BLM-Maximum Flows	East Fork Blacktail Deer Creek	Instream	215.0				
DFWP	East Fork Clover Creek	Instream	4.4				
DFWP	East Fork Dyce Creek	Instream	1.4				
BLM-Minimum Flows	East Fork Dyce Creek	Instream	1.5				
BLM-Maximum Flows	East Fork Dyce Creek	Instream	9.0				
DFWP	Frying Pan Creek	Instream	1.6				
BLM-Minimum Flows	Frying Pan Creek	Instream	1.5				
BLM-Maximum Flows	Frying Pan Creek	Instream	35.0				
DFWP	Grasshopper Creek	Instream	25.8[a]				
DFWP	Hell Roaring Creek	Instream	15.0				
BLM-Minimum Flows	Hell Roaring Creek	Instream	15.0				
BLM-Maximum Flows	Hell Roaring Creek	Instream	250.0				
DFWP	Horse Prairie Creek	Instream	36.0				
DFWP	Indian Creek	Instream	0.2				
BLM-Minimum Flows	Indian Creek	Instream	1.0				
BLM-Maximum Flows	Indian Creek	Instream	5.0				

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Beaverhead River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	Jones Creek	Instream	1.9	Third	Second	Third	
BLM-Minimum Flows	Jones Creek	Instream	2.0	Third	Second	Third	
BLM-Maximum Flows	Jones Creek	Instream	20.0	Third	Second	Third	
DFWP	Long Creek	Instream	3.4	Third	Second	Third	
BLM-Minimum Flows	Long Creek	Instream	5.0	Third	Second	Third	
BLM-Maximum Flows	Long Creek	Instream	110.0	Third	Second	Third	
DFWP	Medicine Lodge Creek	Instream	10.0	Third	Second	Third	
BLM-Minimum Flows	Medicine Lodge Creek	Instream	9.0	Third	Second	Third	
BLM-Maximum Flows	Medicine Lodge Creek	Instream	50.0	Third	Second	Third	
DFWP	Narrows Creek						
	5/1-7/15	Instream	1.2	Third	Second	Third	
	7/16-4/30	Instream	0.5	Third	Second	Third	
DFWP	Odell Creek	Instream	11.0	Third	Second	Third	
BLM-Minimum Flows	Odell Creek	Instream	11.0	Third	Second	Third	
BLM-Maximum Flows	Odell Creek	Instream	225.0	Third	Second	Third	
DFWP	Peet Creek	Instream	0.9	Third	Second	Third	
BLM-Minimum Flows	Peet Creek	Instream	1.5	Third	Second	Third	
BLM-Maximum Flows	Peet Creek	Instream	30.0	Third	Second	Third	
DFWP	Poindexter Slough	Instream	57.9	Third	Second	Third	
DFWP	Rape Creek	Instream	0.4	Third	Second	Third	
BLM-Minimum Flows	Rape Creek	Instream	1.0	Third	Second	Third	
BLM-Maximum Flows	Rape Creek	Instream	5.0	Third	Second	Third	
DFWP	Red Rock Creek	Instream	15.0	Third	Second	Third	
DFWP	Red Rock River #1 above Lima Reservoir	Instream	55.0	Third	Second	Third	
DFWP	Red Rock R. #2 above Clark Canyon Reservoir	Instream	60.0	Third	Second	Third	

Beaverhead River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	Reservoir Creek	Instream	1.5	Third	Second	Third	
DFWP	Shenon Creek	Instream	0.4	Third	Second	Third	
BLM-Minimum Flows	Shenon Creek	Instream	1.0	Third	Second	Third	
BLM-Maximum Flows	Shenon Creek	Instream	13.0	Third	Second	Third	
DFWP	Simpson Creek	Instream	0.7	Third	Second	Third	
BLM-Minimum Flows	Simpson Creek	Instream	1.0	Third	Second	Third	
BLM-Maximum Flows	Simpson Creek	Instream	5.0	Third	Second	Third	
DFWP	Tom Creek	Instream	1.4	Third	Second	Third	
BLM-Minimum Flows	Tom Creek	Instream	2.0	Third	Second	Third	
BLM-Maximum Flows	Tom Creek	Instream	25.0	Third	Second	Third	
DFWP	Trapper Creek	Instream	0.7	Third	Second	Third	
BLM-Minimum Flows	Trapper Creek	Instream	1.0	Third	Second	Third	
BLM-Maximum Flows	Trapper Creek	Instream	10.0	Third	Second	Third	
DFWP	West Fork Blacktail Deer Creek	Instream	3.0	Third	Second	Third	
BLM-Minimum Flows	West Fork Blacktail Deer Creek	Instream	3.0	Third	Second	Third	
BLM-Maximum Flows	West Fork Blacktail Deer Creek	Instream	25.0	Third	Second	Third	
DFWP	West Fork Dyce Creek	Instream	0.7	Third	Second	Third	
BLM-Minimum Flows	West Fork Dyce Creek	Instream	1.0	Third	Second	Third	
BLM-Maximum Flows	West Fork Dyce Creek	Instream	5.0	Third	Second	Third	

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

UPPER MISSOURI SUBBASIN

Missouri River Drainage—Three Forks to Holter Dam

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
East Helena	McClellan Creek/Wells	Municipal	0.9				
Helena	Prickly Pear Creek/Wells	Municipal	16.4				
BR-5	Canyon Ferry Lake	Irrigation	3.0				
BR-11	Canyon Ferry Lake	Irrigation	1.0				
BR-12	Canyon Ferry Lake	Irrigation	1.3				
BR-14	Canyon Ferry Lake	Irrigation	5.6				
BR-103	Canyon Ferry Lake	Irrigation	34.1				
BR-104	Canyon Ferry Lake	Irrigation	151.4				
BR-106	Canyon Ferry Lake	Irrigation	5.6				
BR-107	Canyon Ferry Lake	Irrigation	2.3				
BR-108	Canyon Ferry Lake	Irrigation	1.9				
BR-109	Canyon Ferry Lake	Irrigation	2.1				
BR-110	Canyon Ferry Lake	Irrigation	3.9				
BR-35	Crow Creek/Wells	Irrigation	3.8				
BR-28	Deep Creek/Wells	Irrigation	1.9				
BR-29	Deep Creek/Wells	Irrigation	0.7				
LCI-10	Holter Lake	Irrigation	1.2				
BR-34	Missouri River	Irrigation	3.8				
BR-38	Missouri River	Irrigation	0.8				
BR-50	Missouri River	Irrigation	4.9				
BR-111	Missouri River	Irrigation	0.7				
LC-11	Unnamed tributary of Ten Mile Creek	Irrigation	0.6				
BR-40	Warm Springs Creek/ Wells	Irrigation	1.3				
BR-41	Warm Springs Cr./Wells	Irrigation	5.2				
BR-42	Warm Springs Cr./Wells	Irrigation	0.8				

Missouri River Drainage—Three Forks to Holter Dam (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
BR-44	Warm Springs Creek/ Wells	Irrigation	9.4				
DFWP	Avalanche Creek	Instream	5.0				
DFWP	Beaver Creek	Instream	2.8				
DFWP	Beaver Creek	Instream	10.0				
DFWP	Confederate Gulch	Instream	5.0				
DFWP	Cottonwood Creek	Instream	1.0				
DFWP	Crow Creek	Instream	11.0				
DFWP	Deep Creek	Instream	9.0				
DFWP	Dry Creek	Instream	1.8				
DFWP	Duck Creek	Instream	8.0				
DFWP	McGuire Creek	Instream					
	5/1-11/30	Instream	8.3				
	12/1-4/30	Instream	4.7				

BR = Broadwater County Conservation District
LC and LCI = Lewis and Clark County Conservation District

- First priority of use
- Second priority of use
- Third priority of use
- Not included in this alternative

Missouri River Drainage—Three Forks to Holter Dam
(continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	ALTERNATIVES: INSTREAM	ALTERNATIVES: COMBINATION	ALTERNATIVES: NO ACTION
DHES	Missouri River near Toston	Instream	2596.0				
DFWP	Missouri River #1 above Canyon Ferry Lake	Instream	2400.0				
DFWP	Missouri River #2 Hauser Dam to Holter Lake	Instream	2,881[a]				
DFWP	Prickly Pear Creek #1 above East Helena	Instream	22.0				
DFWP	Prickly Pear Creek #2 above Lake Helena	Instream	30.0				
DFWP	Sevenmile Creek	Instream	1.0				
DFWP	Silver Creek -below Irrigation Canal	Instream					
	5/1-11/30	Instream	13.0				
	12/1-4/30	Instream	5.4				
DFWP	Sixteen Mile Creek	Instream	20.0				
DFWP	Spokane Creek -below Irrigation Canal	Instream					
	5/1-11/30	Instream	4.0				
	12/1-4/30	Instream	3.0				
DFWP	Tenmile Creek	Instream	12.0[a]				
DFWP	Trout Creek- below Vigilante Campground	Instream	15.0				
DFWP	Willow Creek	Instream	3.5				

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Missouri River Drainage—Holter Dam to Belt Creek

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	ALTERNATIVES: INSTREAM	ALTERNATIVES: COMBINATION	ALTERNATIVES: NO ACTION
Great Falls	Missouri (for municipal)	Municipal	28.2	First	First	First	
Great Falls	Missouri (for parks)	Municipal	4.5	First	First	First	
CS-101	Missouri River	Irrigation	2.2	Second	Third	Second	
CS-102	Missouri River	Irrigation	1.4	Second	Third	Second	
CS-111	Missouri River	Irrigation	6.6	Second	Third	Second	
CS-351	Missouri River	Irrigation	2.7	Second	Third	Second	
CS-541	Missouri River	Irrigation	0.5	Second	Third	Second	
CSI-11	Missouri River	Irrigation	2.2	Second	Third	Second	
CSI-12	Missouri River	Irrigation	0.9	Second	Third	Second	
CSI-21	Missouri River	Irrigation	1.5	Second	Third	Second	
CSI-22	Missouri River	Irrigation	1.2	Second	Third	Second	
CSI-23	Missouri River	Irrigation	1.6	Second	Third	Second	
CSI-31	Missouri River	Irrigation	0.8	Second	Third	Second	
CSI-32	Missouri River	Irrigation	0.7	Second	Third	Second	
CSI-33	Missouri River	Irrigation	1.1	Second	Third	Second	
CSI-34	Missouri River	Irrigation	1.2	Second	Third	Second	
CSI-35	Missouri River	Irrigation	1.7	Second	Third	Second	
CSI-41	Missouri River	Irrigation	1.4	Second	Third	Second	
CSI-51	Missouri River	Irrigation	1.8	Second	Third	Second	
CSI-52	Missouri River	Irrigation	4.7	Second	Third	Second	
CSI-101	Missouri River	Irrigation	1.6	Second	Third	Second	
CSI-103	Missouri River	Irrigation	3.7	Second	Third	Second	
LC-210	Missouri River	Irrigation	1.3	Second	Third	Second	
DFWP	Canyon Creek	Instream	10.0	Third	Second	Third	
DFWP	Little Prickly Pear Creek #1 above Clark Creek	Instream	22.0	Third	Second	Third	
DFWP	Little Prickly Pear Creek #2 above mouth	Instream	70.0	Third	Second	Third	

Missouri River Drainage—Holter Dam to Belt Creek
(continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	ALTERNATIVES: INSTREAM	ALTERNATIVES: COMBINATION	ALTERNATIVES: NO ACTION
DFWP	Lyons Creek	Instream	10.0	Third	Second	Third	
DHES	Missouri River at Ulm	Instream	3,204	Third	Second	Third	
DFWP	Missouri River #3 Holter Dam to Great Falls	Instream	3,327 [a]	Third	Second	Third	
DFWP	Sheep Creek	Instream	22.0	Third	Second	Third	
DFWP	Stickney Creek	Instream					
	4/1-4/30	Instream	7.0	Third	Second	Third	
	5/1-5/31	Instream	34.0	Third	Second	Third	
	6/1-6/30	Instream	35.0	Third	Second	Third	
	7/1-7/31	Instream	7.0	Third	Second	Third	
DFWP	Virginia Creek	Instream	6.0	Third	Second	Third	
DFWP	Wegner Creek	Instream					
	4/1-4/30	Instream	8.0	Third	Second	Third	
	5/1-5/31	Instream	41.0	Third	Second	Third	
	6/1-6/30	Instream	38.0	Third	Second	Third	
	7/1-7/31	Instream	8.0	Third	Second	Third	
DFWP	Wolf Creek	Instream	7.0	Third	Second	Third	

CS and CSI = Cascade County Conservation District
LC = Lewis and Clark County Conservation District

- First priority of use
- Second priority of use
- Third priority of use
- Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Smith River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
CS-62	Hound Creek	Irrigation	1.1	Second		Second	
CS-63	Hound Creek	Irrigation	1.8	Second		Second	
CS-64	Hound Creek	Irrigation	0.8	Second		Second	
CS-61	Smith River	Irrigation	1.2	Second		Second	
CS-71	Smith River	Irrigation	0.3	Second		Second	
CS-251	Smith River	Irrigation	1.7	Second		Second	
CS-252	Smith River	Irrigation	0.6	Second		Second	
CS-271	Smith River	Irrigation	0.9	Second		Second	
CS-331	Smith River	Irrigation	0.4	Second		Second	
CSI-102	Smith River	Irrigation	1.3	Second		Second	
CSI-111	Smith River	Irrigation	6.3	Second		Second	
CSI-120	Smith River	Irrigation	3.2	Second		Second	
MEI-11	Smith River	Irrigation	10.9	Second			
MEI-12	Smith River	Irrigation	2.2	Second			
MEI-20	Smith River	Irrigation	2.6	Second			
DFWP	Big Birch Creek	Instream	11.0	Third	Second	Third	
DFWP	Eagle Creek	Instream	2.5	Third	Second	Third	
DFWP	Hound Creek	Instream	35.0	Third	Second	Third	
DFWP	Newlan Creek	Instream	3.8	Third	Second	Third	

CS and CSI = Cascade County Conservation District
MEI = Meagher County Conservation District
LCI = Lewis and Clark County Conservation District

First priority of use — Third priority of use

Second priority of use — Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Smith River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	North Fork Deep Creek	Instream	1.0	Third	Second	Third	
DFWP	North Fork Smith River	Instream	9.0	Third	Second	Third	
DFWP	Rock Creek	Instream	11.0	Third	Second	Third	
DFWP	Sheep Creek	Instream	35.0	Third	Second	Third	
DFWP	Smith River #1 above Sheep Creek	Instream	78.5[a]	Third	Second	Third	
DFWP	Smith River #2 above Hound Creek	Instream	150.0	Third	Second	Third	
DFWP	Smith River #3 above mouth	Instream	80.0	Third	Second	Third	
DFWP	South Fork Smith River	Instream	7.0	Third	Second	Third	
DFWP	Tenderfoot Creek	Instream	15.0	Third	Second	Third	

Dearborn River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
LCI-20	Dearborn River	Irrigation	2.5	Second		Second	
DFWP	Bean Lake	Instream	2,648 af	Third	Second	Third	
DFWP	Dearborn River	Instream	109.0	Third	Second	Third	
DFWP	Flat Creek	Instream	7.5	Third	Second	Third	
DFWP	Middle Fork Dearborn River	Instream	9.5	Third	Second	Third	
DFWP	South Fork Dearborn River	Instream	11.5	Third	Second	Third	

Sun River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Fairfield	Muddy Creek/Wells	Municipal	0.3				
Great Falls	Sun River	Municipal	4.5				
Power	Muddy Creek	Municipal	0.3				
CS-21	Big Coulee	Irrigation	1.0				
TE-181	Big Coulee	Irrigation	3.1				
TE-183	Big Coulee	Irrigation	9.5				
LC-131	Elk Creek	Irrigation	1.0				
TE-571	Muddy Creek	Irrigation	10.5				
CS-31	Sun River	Irrigation	0.8				
CS-32	Sun River	Irrigation	0.7				
CS-51	Sun River	Irrigation	1.5				
CS-52	Sun River	Irrigation	0.7				
CS-171	Sun River	Irrigation	0.5				
CS-231	Sun River	Irrigation	0.2				
CS-241	Sun River	Irrigation	1.5				
CS-471	Sun River	Irrigation	0.9				
CSI-71	Sun River	Irrigation	1.3				
CSI-81	Sun River	Irrigation	0.7				
CSI-82	Sun River	Irrigation	1.0				
CSI-83	Sun River	Irrigation	0.5				
CSI-91	Sun River	Irrigation	1.0				
CSI-92	Sun River	Irrigation	0.5				
CSS-200	Sun River	Irrigation	82.0				

Sun River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
TEI-80	Sun River	Irrigation	1.6				
TEI-90	Sun River	Irrigation	0.8				
TEI-100	Sun River	Irrigation	1.2				
LC-251	Unnamed tributary of Smith Creek	Irrigation	2.0				
DFWP	Elk Creek	Instream	16.0				
DFWP	Ford Creek	Instream	12.0				
DFWP	North Fork Willow Creek	Instream	3.0				
DFWP	Sun River #1 above Elk Creek	Instream	100.0				
DFWP	Sun River #2 above mouth	Instream	130.0				
DFWP	Willow Creek	Instream	3.0				

CS, CSI, and CSS = Cascade County Conservation District
LC = Lewis and Clark County Conservation District
TE and TEI = Teton County Conservation District

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

Belt Creek Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
CS-42	Belt Creek	Irrigation	5.9				
CS-43	Belt Creek	Irrigation	4.0				
CS-44	Belt Creek	Irrigation	0.6				
CS-159	Belt Creek	Irrigation	0.8				
CHS-1	Belt Creek	Irrigation	20.2				
JB-281	Big Otter Creek	Irrigation	0.4				
JB-61	Little Otter Creek	Irrigation	2.2				
DFWP	Belt Creek #1 above Big Otter Creek	Instream	90.0				
DFWP	Belt Creek #2 above mouth	Instream	35.0				
DFWP	Big Otter Creek	Instream	5.0				
DFWP	Dry Fork Belt Creek	Instream	7.0				
DFWP	Logging Creek	Instream	6.0				
DFWP	Pilgrim Creek	Instream	8.0				
DFWP	Tillinghast Creek	Instream	5.5				

CS = Cascade County Conservation District
CHS = Chouteau County Conservation District
JB = Judith Basin County Conservation District

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

MARIAS/TETON SUBBASIN

Marias River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Chester	Tiber Reservoir	Municipal	1.0				
Conrad	Lake Francis	Municipal	5.5				
Cut Bank	Cut Bank Creek	Municipal	3.4				
Shelby	Marias River/Wells	Municipal	1.8				
PO-171	Birch Creek	Irrigation	1.8				
PO-251	Birch Creek	Irrigation	0.8				
GL-11	Cut Bank Creek	Irrigation	3.7				
GL-221	Cut Bank Creek	Irrigation	4.4				
PO-211	Dry Fork Marias River	Irrigation	1.0				
PO-91	Laughlin Coulee	Irrigation	1 0				
BS-31	Marias River	Irrigation	0.5				
BSS-2	Marias River	Irrigation	289.6				
BS-32	Marias River	Irrigation	9.9				
CHI-51	Marias River	Irrigation	1.6				
CHI-52	Marias River	Irrigation	3.3				
CHI-53	Marias River	Irrigation	1.9				
HI-269	Marias River	Irrigation	18.8				
LI-91	Marias River	Irrigation	3.5				
LI-161	Marias River	Irrigation	6.8				
LI-162	Marias River	Irrigation	4.7				
LI-261	Marias River	Irrigation	24.3				
LI-262	Marias River	Irrigation	10.5				
LI-263	Marias River	Irrigation	2.0				
TO-221	Marias River	Irrigation	1.3				
TO-211	Tiber Reservoir	Irrigation	10.2				
TO-341	Tiber Reservoir	Irrigation	3.4				
TO-342	Tiber Reservoir	Irrigation	3.9				

Marias River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
TO-421	Timber Coulee	Irrigation	0.8				
PO-421	Two Medicine River	Irrigation	3.2				
POI-10	Two Medicine River	Irrigation	5.3				
PO-271	Unnamed tributary of Bullhead Creek	Irrigation	0.9				
PO-411	Unnamed tributary of Bullhead Creek	Irrigation	2.1				
GL-201	Whitetail Creek	Irrigation	3.4				
DFWP	Badger Creek	Instream	60.0				
DFWP	Birch Creek	Instream	64.0				
DFWP	Cut Bank Creek	Instream	75.0				
DFWP	Dupuyer Creek	Instream	12.0				
DFWP	Marias River #1 above Tiber Reservoir	Instream	200.0				
DFWP	Marias River #2 above Highway 223	Instream	419.5[a]				
DFWP	Marias River #3 above mouth	Instream	488.5[a]				
DFWP	North Badger Creek	Instream	14.0				
DFWP	North Fork Dupuyer Creek	Instream	12.0				
DFWP	South Badger Creek	Instream	40.0				
DFWP	South Fork Dupuyer Creek	Instream	6.0				
DFWP	South Fork Two Medicine River	Instream	16.0				

BS and BSS = Big Sandy Conservation District
CHI = Chouteau County Conservation District
GL = Glacier County Conservation District
HI = Hill County Conservation District
LI = Liberty County Conservation District
PO and POI = Pondera County Conservation District
TO = Toole County Conservation District

First priority of use
Second priority of use
Third priority of use
Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Teton River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Choteau	Teton River/Wells	Municipal	1.8				
CH-641	Alkali Coulee	Irrigation	0.0				
TE-581	Gamble Coulee	Irrigation	2.2				
TE-591	Gamble Coulee	Irrigation	11.2				
TE-81	Muddy Creek	Irrigation	0.2				
TE-101	Muddy Creek	Irrigation	1.4				
TE-361	Spring Coulee	Irrigation	2.5				
CH-381	Teton River	Irrigation	9.9				
CHI-61	Teton River	Irrigation	1.7				
CHI-72	Teton River	Irrigation	0.7				
CHI-74	Teton River	Irrigation	0.7				
CHI-80	Teton River	Irrigation	0.8				
TE-281	Teton River	Irrigation	0.9				
TE-282	Teton River	Irrigation	1.7				
TE-321	Teton River	Irrigation	6.5				
TE-411	Teton River	Irrigation	0.9				
TEI-10	Teton River	Irrigation	2.5				
TEI-20	Teton River	Irrigation	1.7				
TEI-30	Teton River	Irrigation	22.4				
TEI-40	Teton River	Irrigation	0.9				
TEI-50	Teton River	Irrigation	3.5				
TEI-60	Teton River	Irrigation	11.0				

Teton River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
TEI-70	Teton River	Irrigation	4.4				
TE-401	Unnamed tributary of Teton River	Irrigation	2.7				
DFWP	Antelope Butte Swamp	Instream	450.0 af				
DFWP	Deep Creek	Instream	18.0				
DFWP	McDonald Creek	Instream	10.0				
DFWP	North Fork Deep Creek	Instream	7.2				
DFWP	South Fork Deep Creek	Instream	6.9				
DFWP	Spring Creek	Instream	4.5				
DFWP	Upper Teton River	Instream	35.0				

CH and CHI = Chouteau County Conservation District
TE and TEI = Teton County Conservation District

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

MIDDLE MISSOURI SUBBASIN

Missouri River Drainage—Belt Creek to Fort Peck Reservoir

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Fort Benton	Missouri River	Municipal	0.8	First priority of use	First priority of use	First priority of use	
CHFG-181	Cut Bank Coulee	Irrigation	7.9	Second priority of use	Second priority of use	Third priority of use	
CH-541	Highwood Creek	Irrigation	0.2	Second priority of use		Second priority of use	
BUREC.	Missouri River near Virgelle	Irrigation	280.0	Second priority of use			
CH-21	Missouri River	Irrigation	2.6	Second priority of use	Third priority of use	Second priority of use	
CH-211	Missouri River	Irrigation	2.9	Second priority of use	Third priority of use	Second priority of use	
CH-371	Missouri River	Irrigation	0.2	Second priority of use			
CH-511	Missouri River	Irrigation	10.2	Second priority of use		Second priority of use	
CHI-10	Missouri River	Irrigation	2.4	Second priority of use	Third priority of use	Second priority of use	
CHI-21	Missouri River	Irrigation	5.3	Second priority of use	Third priority of use	Second priority of use	
CHI-22	Missouri River	Irrigation	3.1	Second priority of use	Third priority of use	Second priority of use	
CHI-30	Missouri River	Irrigation	4.2	Second priority of use	Third priority of use	Second priority of use	
CHI-40	Missouri River	Irrigation	1.9	Second priority of use	Third priority of use	Second priority of use	
CHS-3	Missouri River	Irrigation	127.6	Second priority of use		Second priority of use	
CHS-5	Missouri River	Irrigation	58.8	Second priority of use		Second priority of use	
CHS-6	Missouri River	Irrigation	233.0	Second priority of use			
FEI-10	Missouri River	Irrigation	1.6	Second priority of use	Third priority of use	Second priority of use	
FEI-20	Missouri River	Irrigation	2.2	Second priority of use		Second priority of use	
FEI-30	Missouri River	Irrigation	0.8	Second priority of use		Second priority of use	
CH-201	Shonkin Creek	Irrigation	0.5	Second priority of use	Third priority of use	Second priority of use	

Missouri River Drainage—Belt Creek to Fort Peck Reservoir (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
CH-551	Unnamed tributary of Big Sag Creek	Irrigation	0.6	Second priority of use	Third priority of use	Second priority of use	
DFWP	Cow Creek	Instream	4.5	Third priority of use	Second priority of use	Third priority of use	
DFWP	Highwood Creek	Instream	10.0	Third priority of use	Second priority of use	Third priority of use	
DFWP	Missouri River #4 - Great Falls to Marias R.	Instream	3,876 [a]	Third priority of use	Second priority of use	Third priority of use	
DHES	Missouri River at Virgelle	Instream	4,390 [a]	Third priority of use	Second priority of use	Third priority of use	
DFWP	Missouri River #5 - Marias to Judith River	Instream	4,280 [a]	Third priority of use	Second priority of use	Third priority of use	
DHES	Missouri River at Landusky	Instream	4,652 [a]	Third priority of use	Second priority of use	Third priority of use	
DFWP	Missouri River #6-Judith to Fort Peck Reservoir	Instream	4,652 [a]	Third priority of use	Second priority of use	Third priority of use	
DFWP	Shonkin Creek	Instream	7.0	Third priority of use	Second priority of use	Third priority of use	

CH, CHI, CHFG, and CHS = Chouteau County Conservation District
FEI = Fergus County Conservation District

- First priority of use
- Second priority of use
- Third priority of use
- Not included in this alternative

a Instream flow requests that have been reduced to ½ the average annual flow

Judith River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
Lewistown	Big Spring Creek	Municipal	3.6				
Winifred	Judith River/Wells	Municipal	0.3				
FE-111	Big Spring Creek	Irrigation	0.2				
FE-401	East Fork Big Spring Creek	Irrigation	0.6				
FE-41	Judith River	Irrigation	0.9				
FEI-50	Judith River	Irrigation	63.5				
JBI-2	Judith River	Irrigation	13.1				
FE-431	Little Casino Creek	Irrigation	1.1				
JB-309	Little Trout Creek	Irrigation	0.4				
JB-21	Louse Creek	Irrigation	0.2				
JB-231	Louse Creek/Well	Irrigation	0.8				
JB-232	Louse Creek/Well	Irrigation	0.8				
JB-111	McCarthy Creek	Irrigation	1.0				
FE-671	Olsen Creek	Irrigation	6.4				
FE-673	Unnamed tributary of Ross Fork Creek	Irrigation	1.1				
JB-261	Running Wolf Creek	Irrigation	3.7				
JBS-3	Wolf Creek	Irrigation	3.3				
FE-42	Unnamed tributary of Cambell Coulee	Irrigation	0.4				
FE-672	Unnamed tributary of Olsen Creek	Irrigation	3.8				
FE-161	Warm Springs Creek	Irrigation	2.2				
FE-561	Warm Springs Creek	Irrigation	3.3				
FEI-40	Warm Springs Creek	Irrigation	13.7				
FE-81	Wolf Creek	Irrigation	3.3				
FE-141	Wolverine Creek	Irrigation	3.3				

Judith River Drainage (continued)

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
DFWP	Beaver Creek	Instream	5.0				
DFWP	Big Spring Ck. #1 - hatchery to Cottonwood Creek	Instream	53.5[a]				
DFWP	Big Spring Creek #2 - above mouth	Instream	100.0				
DFWP	Cottonwood Creek	Instream	4.5				
DFWP	East Fork Big Spring Creek	Instream	7.5				
DFWP	Judith River #1 - above Big Spring Creek	Instream	25.0				
DFWP	Judith River #2 - above mouth	Instream	160.0				
DFWP	Lost Fork Judith River	Instream	14.0				
DFWP	Middle Fork Judith River	Instream	22.0				
DFWP	South Fork Judith River	Instream	3.5				
DFWP	Warm Spring Creek	Instream	110.0				
DFWP	Yogo Creek	Instream	3.0				

FE and FEI = Fergus County Conservation District
JB, JBI and JBS = Judith Basin County Conservation District

- First priority of use
- Second priority of use
- Third priority of use
- Not included in this alternative

a Instream flow requests that have been reduced to 1/2 the average annual flow

Musselshell River Drainage

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
LM-20	Musselshell River	Irrigation	90.0				
DFWP	Alabaugh Creek	Instream	12.0				
DFWP	American Fork Creek	Instream	5.5				
DFWP	Big Elk Creek	Instream	9.5				
DFWP	Careless Creek	Instream	2.0				
DFWP	Checkerboard Creek	Instream	6.0				
DFWP	Collar Gulch Creek	Instream	0.6				
DFWP	Cottonwood Creek	Instream	16.0				
DFWP	Flatwillow Creek	Instream	15.0*				
DFWP	Musselshell River #1 - above Deadmans Basin	Instream	80.0				
DFWP	Musselshell R. #2 - abv. Musselshell Diversion	Instream	80.0				
DFWP	Musselshell River #3 - above mouth	Instream	70.0				
DFWP	N. Fk. Musselshell R. #1 - above Bair Reservoir	Instream	3.0				
DFWP	N. Fk. Musselshell R. #2 - above S. Fk. Musselshell R.	Instream	16.0				
DFWP	South Fork Musselshell River	Instream	30.0				
DFWP	Spring Creek	Instream	8.0				
DFWP	Swimming Woman Creek	Instream	2.5				

Fort Peck Reservoir Drainage and small tributaries

APPLICANT/ PROJECT	SOURCE	TYPE OF RESERVATION	AMOUNT (cfs)	ALTERNATIVES: CONSUMPTIVE USE	INSTREAM	COMBINATION	NO ACTION
VAS-1	Fort Peck Reservoir	Irrigation	499.1				
DFWP	Big Dry Creek						
	3/15-3/31	Instream	300.0				
	4/1-4/30	Instream	100.0				
	5/1-5/31	Instream	35.0				
	6/1-10/31	Instream	5.5				
DFWP	Little Dry Creek						
	3/15-3/31	Instream	110.0				
	4/1-4/30	Instream	42.0				
	5/1-5/31	Instream	17.0				
	6/1-10/31	Instream	3.5				

LM = Lower Musselshell Conservation District
VAS = Valley County Conservation District

First priority of use

Second priority of use

Third priority of use

Not included in this alternative

CHAPTER SIX
IMPACTS

INTRODUCTION

In this chapter, the environmental effects that would result from each alternative presented in Chapter Five are analyzed. In developing this chapter, DNRC used environmental assessments of each reservation application, results from the Missouri River Water Availability Model, and other sources of information as cited in the text. The individual environmental assessments are available on request from DNRC by calling (406) 444-6812, or by writing: EAs, Montana Department of Natural Resources and Conservation, 1520 East 6th Avenue, Helena, MT 59620-2301.

The reservation process requires the applicants to submit only reconnaissance level project designs and development schedules, so specific details necessary to analyze environmental effects thoroughly were unavailable for some projects. This is especially true for the 14 irrigation projects (Table 6-1) larger than 2,500 acres where design details such as electric line locations, diversion structures, and pipelines are not given. Also, Bozeman's application to reserve water for a reservoir does not contain many specifics, especially in regard to reservoir operations. To comply with MEPA, additional environmental review may be required before large projects can be

Table 6-1. Irrigation projects greater than 2,500 acres

		Alternative					
		Consumptive Use		Instream		Combination	
Subbasin	Drainage	Project	Acreage	Project	Acreage	Project	Acreage
Headwaters	Madison River	GA-201	7,890	—[a]	0	GA-201	7,890
	Jefferson River	JV-201	4,175	—	0	—	0
		JV-202	4,950	—	0	—	0
		BR-101	3,290	—	0	BR-101	3,290
	SUBBASIN TOTAL		20,305		0		11,180
Upper Missouri	Missouri River - Three Forks to Holter Dam	BR-104	6,095	—	0	—	0
	Sun River	CSS-200	5,053	—	0	—	0
	SUBBASIN TOTAL		11,148		0		0
Marias/Teton	Marias River	BSS-2	19,230	—	0	—	0
	SUBBASIN TOTAL		19,230		0		0
Middle Missouri	Missouri River - Belt Creek to Fort Peck Reservoir	CHS-6	15,382	—	0	—	0
		CHS-5	3,905	—	0	CHS-5	3,905
		CHS-3	8,475	—	0	CHS-3	8,475
		BUREC	53,600	—	0	BUREC	53,600
	Judith River	FEI-50	4,218	—	0	—	0
	Musselshell River	LM-20	3,119	—	0	—	0
	Fort Peck Reservoir	VAS-1	25,020	VAS-1	25,020	VAS-1	25,020
	SUBBASIN TOTAL		113,719		25,020		91,000
TOTAL ALL SUBBASINS			164,402		25,020		102,180

[a] blank space indicates a project is not included in that alternative

developed and, in some cases, this may involve the preparation of a project-specific EIS. The Board may require DNRC to conduct a separate environmental review or may choose to conduct a joint environmental review with other state or federal agencies having jurisdiction over project development (ARM 36.2.522). BUREC intends to write a separate federal EIS before constructing the Virgelle diversion project.

WATER QUANTITY AND DISTRIBUTION

GENERAL IMPACTS AND CONSIDERATIONS

The use of additional water for irrigation and municipal needs would alter streamflows and groundwater levels. Instream flow reservations would not directly affect the existing water quantity or distribution, but could have indirect effects. The following paragraphs identify general ways in which the quantity and distribution of water in streams and reservoirs would be affected by the proposed reservations under the three alternatives.

Much of the water diverted for irrigation evaporates or is consumed by plants. Excess water applied to crops returns to a stream as surface runoff or seeps into the ground and moves downward to the water table. In instances where a stream and water table are connected, this water may, over time, return to the stream. Water that leaks from canals also may return to a stream. Excess water that discharges to a stream is referred to as irrigation return flow. Return flows typically are greatest from flood irrigation systems. Most of the new irrigation projects proposed by the reservants would use more efficient sprinkler systems and return flows would be less. Model results show that in some cases irrigation return flows lessen impacts of irrigation withdrawals during the summer and early fall and increase streamflows slightly in the late fall, winter, and early spring.

Some of the water diverted for municipal use will be lost to evaporation or consumed, primarily by lawns and gardens. Most water used for household purposes will pass through wastewater treatment facilities and then return to the stream or aquifer. Water also can leak into the ground from inefficient city distribution systems and eventually return to a stream or aquifer.

Any reservations granted by the Board would be senior to water use permits with priority dates after July 1, 1985 (unless the Board chooses to subordinate the reservations to these permits). Because of this, reservations could preclude existing water users with priority dates later than July 1, 1985, from diverting water during times of low flow. In the case of instream reservations, this might increase streamflows slightly. Appendix A lists post July 1, 1985, permits and permit applications. The flow rates listed for the post July 1, 1985 permits for uses such as irrigation that divert water during the summer months, provide an indication of maximum increases in flows that could occur in a particular drainage as a result of instream reservations.

TERMINOLOGY AND CONCEPTS

Throughout this chapter, references are made to "wet," "average," and "dry" years. Wet years are years in which average monthly flows at a given point are exceeded in only 2 out of 10 years over a long-term average. These wet year flows also are referred to as 20th percentile exceedance flows. Dry years are years in which average monthly flows at a given point are exceeded in 8 out of 10 years on the average. Dry year flows are referred to as 80th percentile exceedance flows. Figure 6-1 illustrates streamflows by comparing 20th and 80th percentile exceedance flows to actual flows for wet and dry years using the Missouri River at Virgelle.

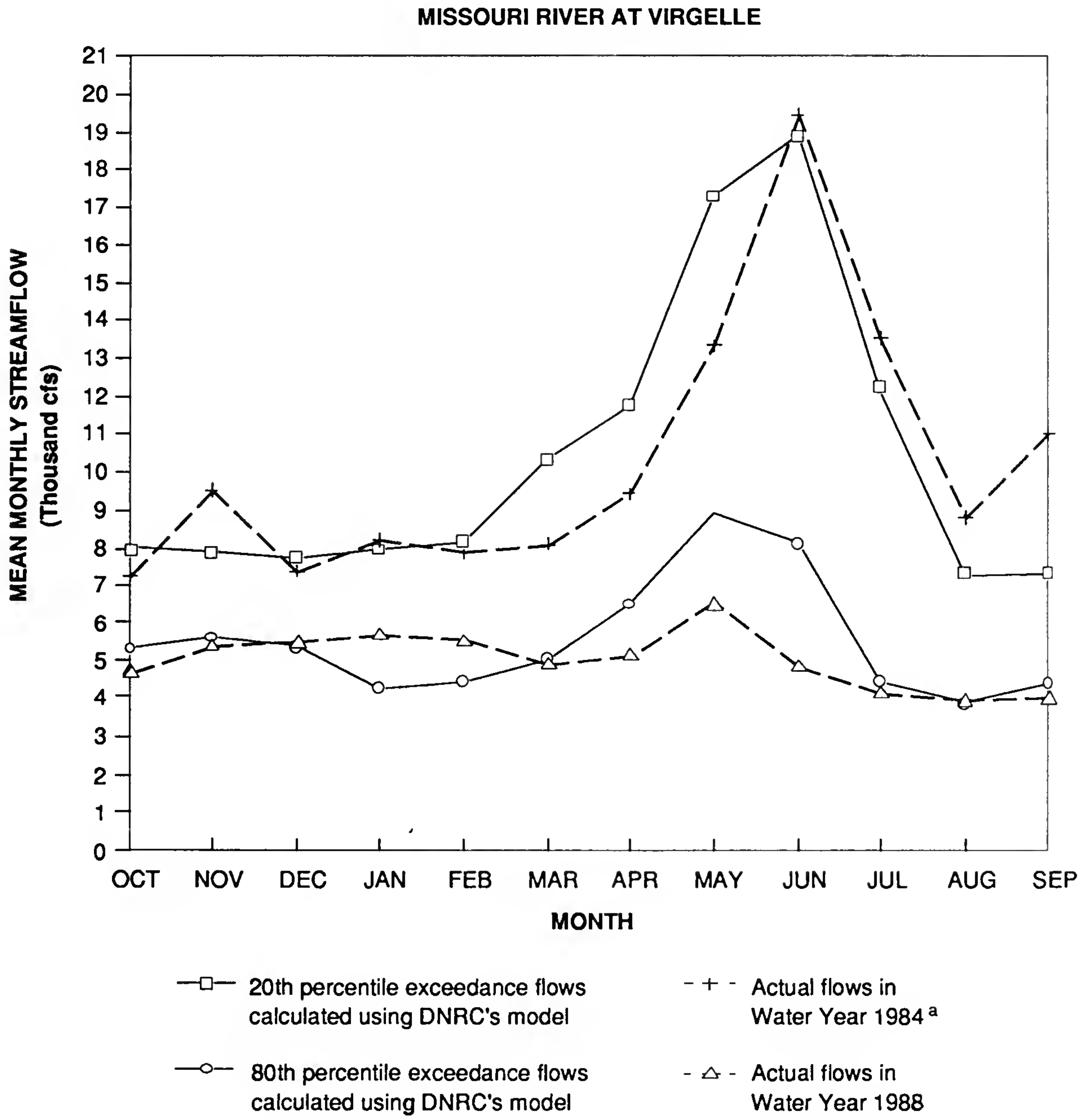
Average years also are discussed in this chapter and refer to years in which average monthly flows at a given point are exceeded in 5 out of 10 (50th percentile exceedance) years. These "average year" flows are also referred to as median flows.

Irrigation projects are not included under the Instream Alternative unless water is still available after the instream requests are satisfied in, at least, the wettest 6 years in 10.

Appendix C contains a listing of predicted monthly streamflows for all points analyzed in the computer model under existing conditions and for the three alternatives discussed here. Appendix C also contains a corresponding list of monthly streamflow reductions that would occur under the three alternatives.

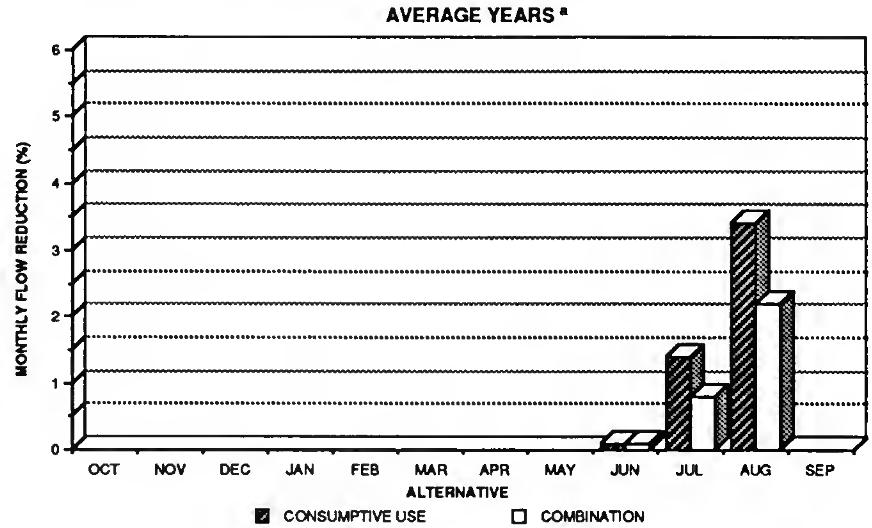
It should be noted that changes in streamflow patterns from the consumptive use reservations would reach the magnitudes discussed below only after proposed projects are fully developed.

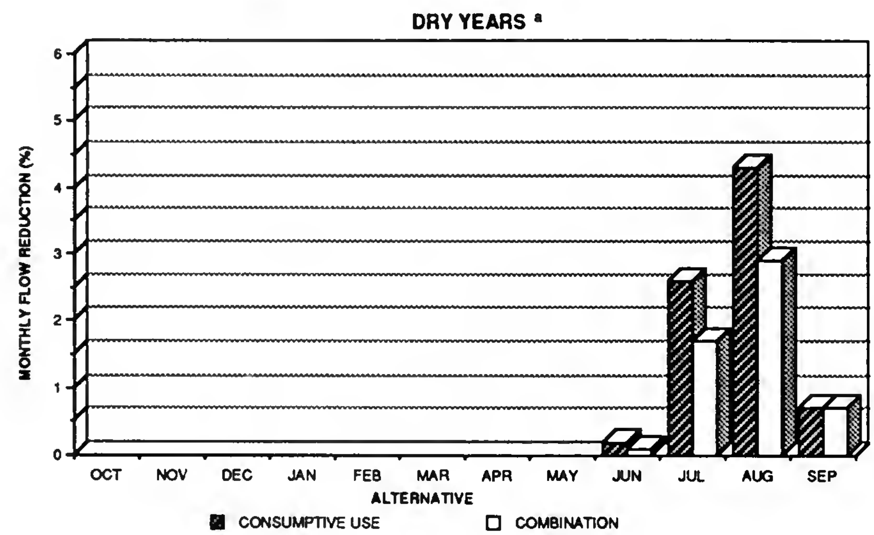
Figure 6-1. Typical hydrographs for wet and dry years



[a] A "water year" begins on October 1st of the preceding calendar year and ends on September 30th.

Figure 6-2. Monthly flow reductions in the Gallatin River near Logan





[a] No irrigation projects are included under the Instream Alternative in this drainage.

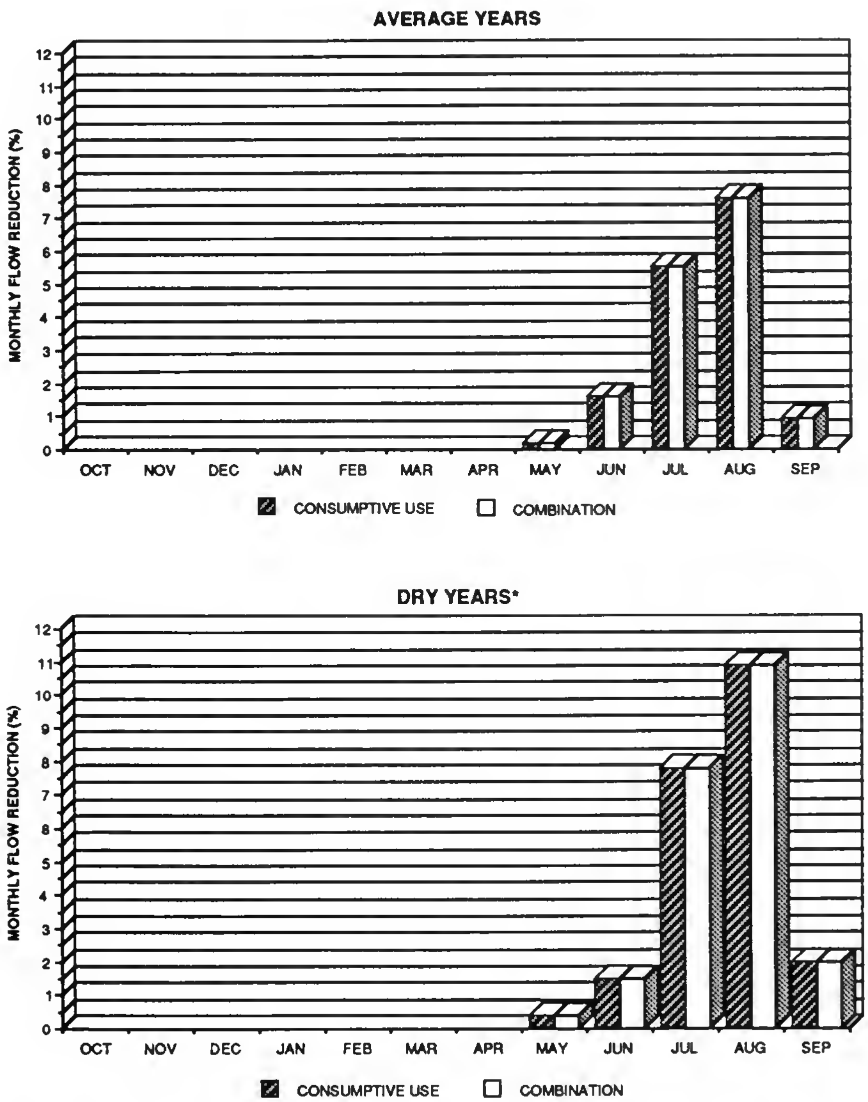
Impacts of the Consumptive Use, Instream, and Combination Alternatives

Gallatin River Drainage

All proposed irrigation projects in the Gallatin drainage and the municipal request by Belgrade would use groundwater. Pumping to supply water for these projects could lower groundwater in some areas. Declining groundwater levels have already been noted in the Gallatin Valley (Compton and Mack 1989). Because surface water and groundwater in the drainage are generally interconnected, groundwater pumping would eventually reduce streamflows.

Small streamflow reductions would occur in the Gallatin River during the summer irrigation months under the Consumptive Use and Combination alternatives. These streamflow reductions are depicted in bar charts in Figure 6-2 for the Gallatin River near Logan. Flow reductions would average 21 cfs in July and August, and most would originate in the East Gallatin drainage where the average July and August flows at Bozeman are only 74 and 49 cfs

Figure 6-3. Monthly flow reductions in the Madison River near Three Forks



[a] No irrigation projects are included under the Instream Alternative in this drainage.

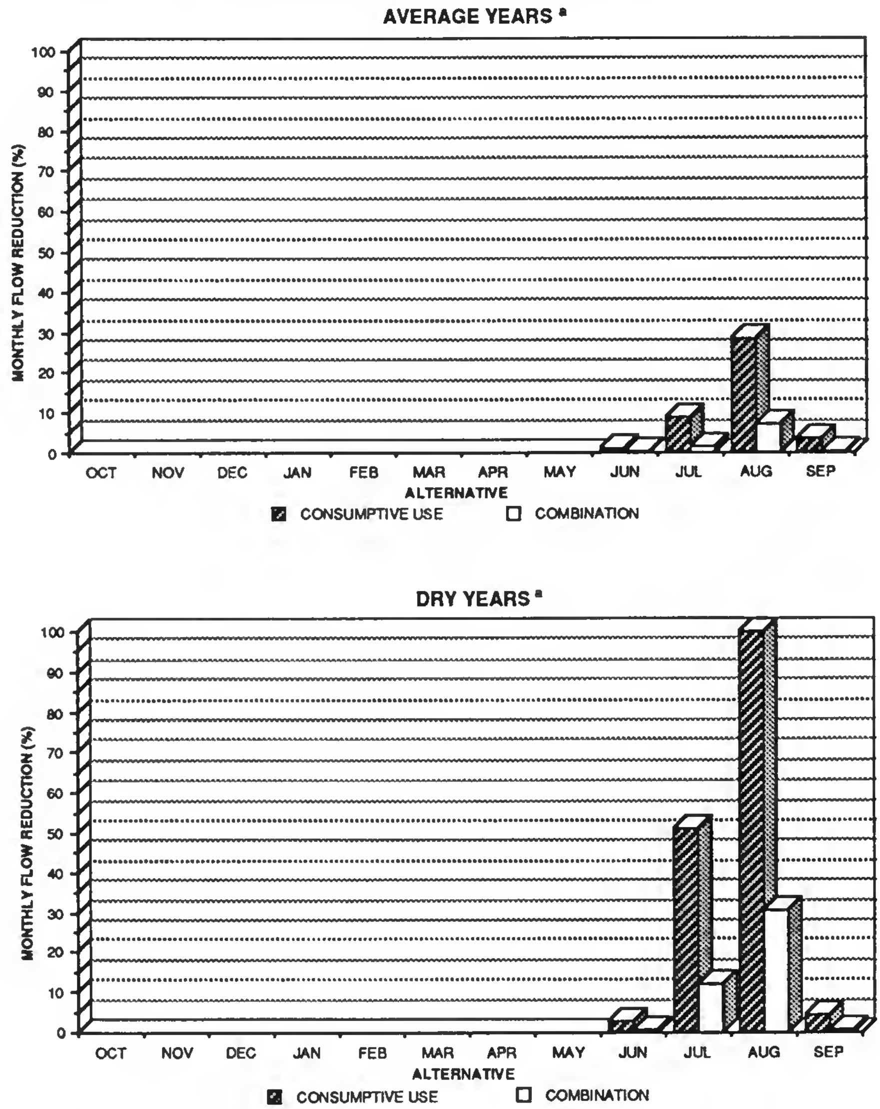
(Appendix C). The surface water impacts described here are based on the assumption that when water is pumped from the proposed wells, that same amount of water would be removed from associated streamflows.

Under all three alternatives, streamflow patterns in Sourdough Creek would be altered with the completion of the proposed reservoir by the City of Bozeman. The timing and magnitude of these alterations are difficult to predict, given the lack of detail regarding reservoir operations in the city's application.

Madison River Drainage

Under the Consumptive Use and Combination alternatives, streamflows would be reduced in the lower Madison River during the summer of wet, dry, and average years as shown in Figure 6-3. Under all three alternatives, flows would be reduced in the creek fed by Whiskey Springs when West Yellowstone increases its municipal use. The average flow of the creek is approximately 6.7 cfs (HKM 1987), and the reservation request calls for additional peak withdrawal of 0.8 cfs.

Figure 6-4. Monthly flow reductions in the Jefferson River near Three Forks



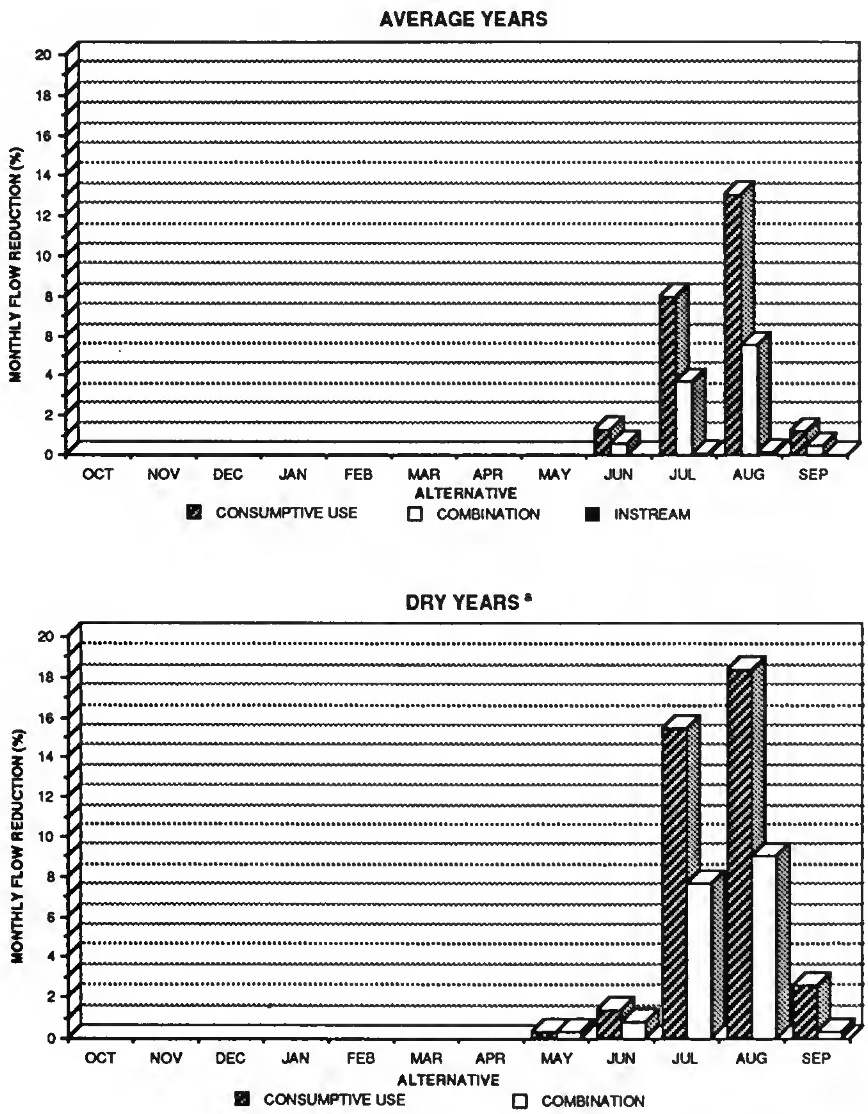
[a] No irrigation projects are included under the Instream Alternative in this drainage.

Jefferson and Boulder River Drainages

Summer flows in the Jefferson River near Waterloo, already very low or nonexistent in some years, would be reduced further. Average July and August flows near Three Forks would drop substantially under the Consumptive Use Alternative as shown in Figure 6-4. The reductions would be greatest in dry years with significant impacts under the Consumptive Use and Combination alternatives. Under the Consumptive Use Alternative, flows would cease near Three Forks during the driest 2 out of 10 years in August and the driest 1 out of 10 years in July. Even in wet years, August flows would decline 18.4 percent under the Consumptive Use Alternative.

Under the Consumptive Use and Combination alternatives, five proposed irrigation projects would pump water from aquifers immediately adjacent to the Boulder River. Because of the proximity of the wells to the stream, flows in the Boulder River may be reduced from the August average flow of 31 cfs (Appendix D) to 27.5 cfs. Existing low-flow problems in the Boulder River would worsen during dry years.

Figure 6-5. Monthly flow reductions in the Missouri River at Toston



[a] No reductions would occur under the Instream Alternative during dry years.

Big Hole, Beaverhead, Ruby and Red Rock Drainages

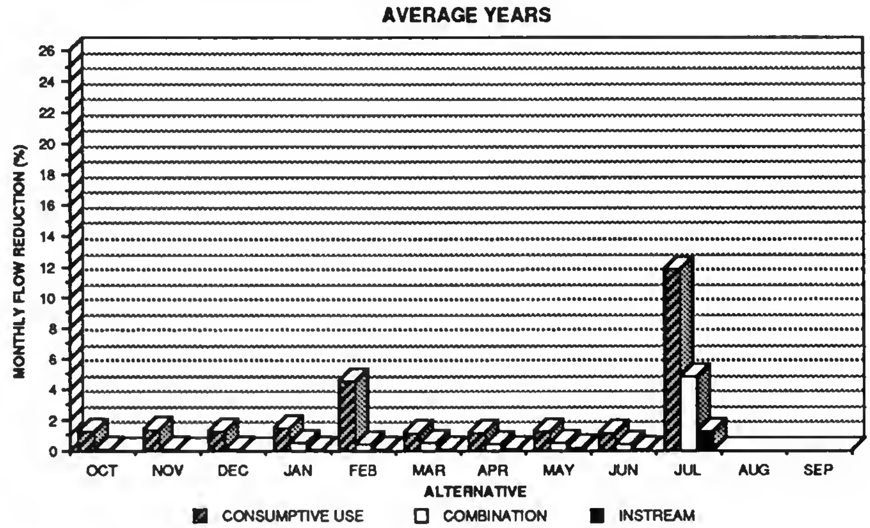
The only new consumptive use proposed in these drainages is a well which would reduce flows only slightly in the Beaverhead River under the three alternatives.

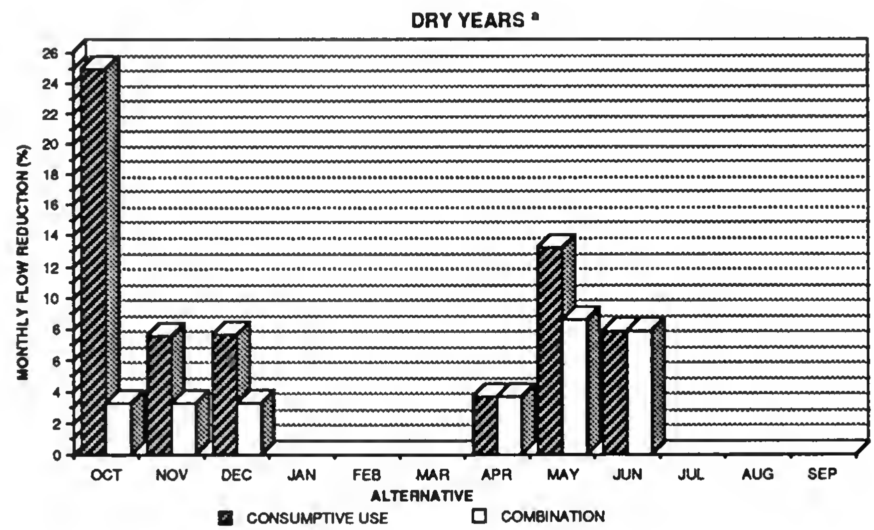
Missouri River Drainage - Three Forks to Holter Dam

Under the Consumptive Use and Combination alternatives, summer flows would be reduced in the Missouri River above Canyon Ferry Reservoir. At Toston, average July and August flows would decrease particularly during dry years (see Figure 6-5).

Under the Consumptive Use Alternative, the water elevation in Canyon Ferry Reservoir in any month would be reduced 2 feet or less in average years and wet years, and as much as 4 feet during September and October in dry years. The long-term average reduction in reservoir elevation would be approximately 1 foot, while total water that spills over the dam without producing power would decrease approximately 5 percent. Total annual outflows from Canyon Ferry Reservoir would decrease 2.3 percent and monthly outflows from Canyon Ferry would decrease as shown in Figure 6-6.

Figure 6-6. Monthly reductions in outflows from Canyon Ferry Reservoir





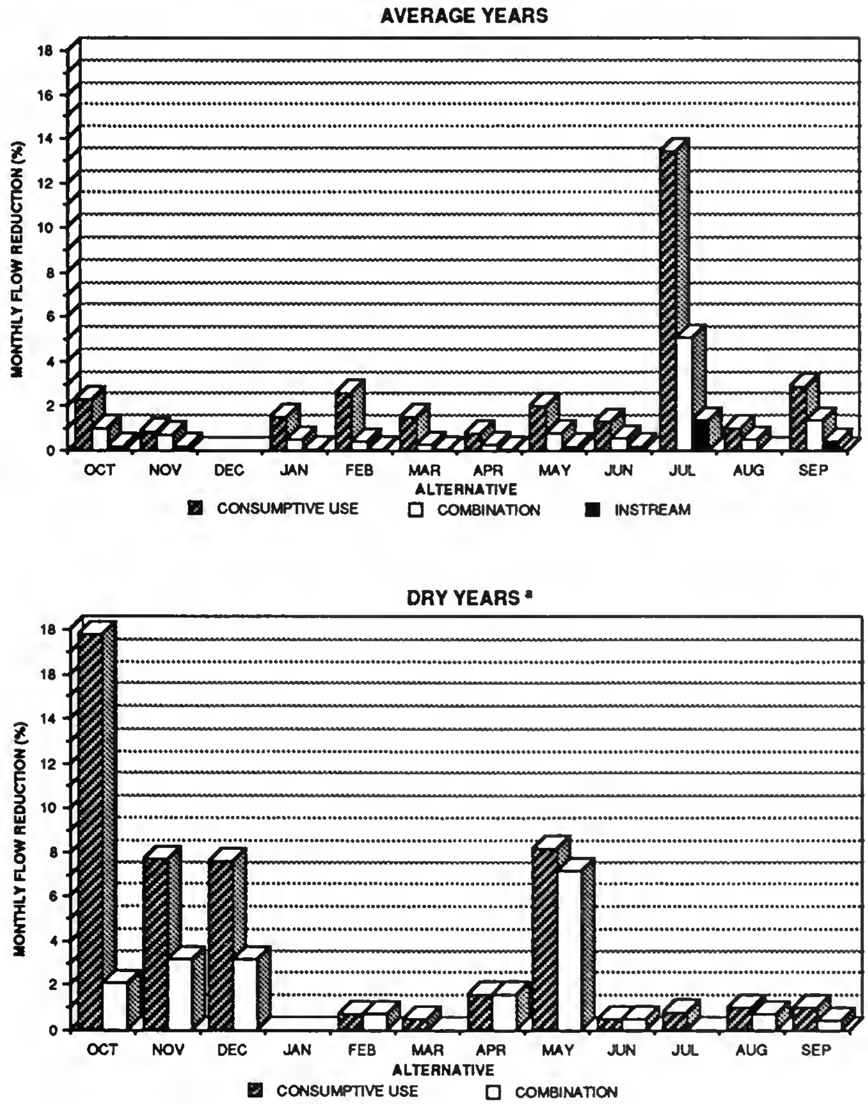
[a] No reductions would occur under the Instream Alternative during dry years.

Under the Combination Alternative, the average water elevation in Canyon Ferry Reservoir in any month would be reduced less than 2 feet during wet, average, and dry years. The long-term average reduction in reservoir elevation would be approximately 1 foot. Total water spilling over the dam and not generating electricity would not change substantially. Monthly reductions in outflows from Canyon Ferry Reservoir under the Combination Alternative are shown in Figure 6-6.

Under the Instream Alternative, reductions in streamflows above Canyon Ferry Reservoir would be relatively small. Water storage in Canyon Ferry would be only slightly affected. The long-term average reduction in reservoir elevation would be less than 1 foot. The amount of water spilling over the dam without generating electricity would be reduced slightly. For all practical purposes, the timing and volume of outflows from Canyon Ferry would not be affected. All the impacts outlined above assume that Canyon Ferry's operating regime will not change in the future.

Under all alternatives, streamflows would decline in Deep Creek, Crow Creek, and Warm Springs Creek, all tributaries to the Missouri River. During dry years and under the Consumptive Use Alterna-

Figure 6-7. Monthly flow reductions in the Missouri River below Hauser Reservoir



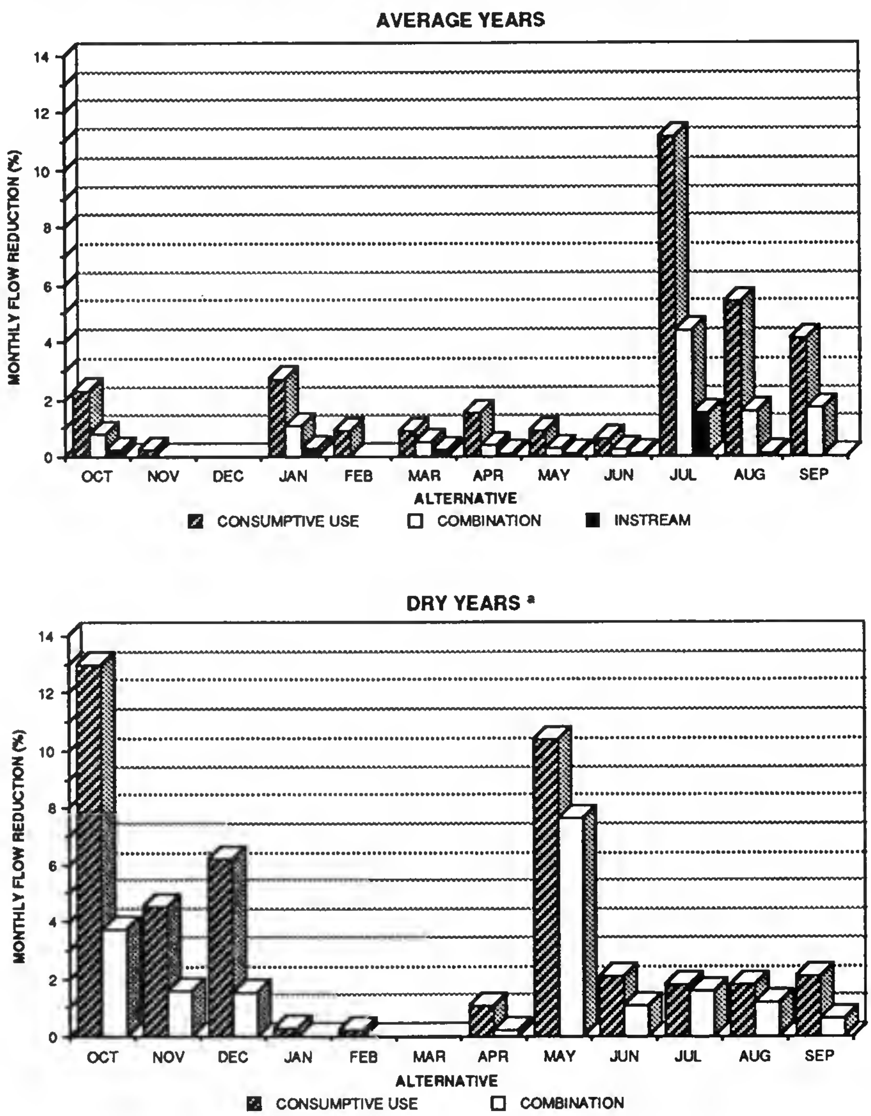
[a] Reductions during dry years under the Instream Alternative would be small.

tive, Deep Creek's average July and August flows of 18 and 10 cfs would be reduced by 1.5 and 2.0 cfs. Much of the flow of Deep Creek is diverted by an irrigation canal below the proposed projects, causing the streams to go dry below this point. For both the Consumptive Use and Combination alternatives, flow reductions in Crow Creek would be greatest during August in dry years, with average flows of 15 cfs declining as much as 2.2 cfs. Warm Springs Creek flows would decline approximately 12 cfs from DNRC's estimated July and August flows of 40 and 15 cfs under the Consumptive Use and Combination alternatives. Irrigation projects that would pump groundwater would lower water levels in aquifers adjacent to these streams.

Flows would decline in Prickly Pear Creek and its tributaries under all alternatives. Reductions would be greatest during August in dry years, with average flows near East Helena declining approximately 9 percent. Dewatering of the stream below East Helena would increase.

Under the Consumptive Use Alternative, monthly flows would be reduced for both average and dry years downstream from Hauser and Holter reservoirs. These reductions are shown in Figures 6-7 and 6-8.

Figure 6-8. Monthly flow reductions in the Missouri River below Holter Reservoir



[a] No reductions would occur under the Instream Alternative during dry years.

Missouri River Drainage - Holter Dam to Belt Creek

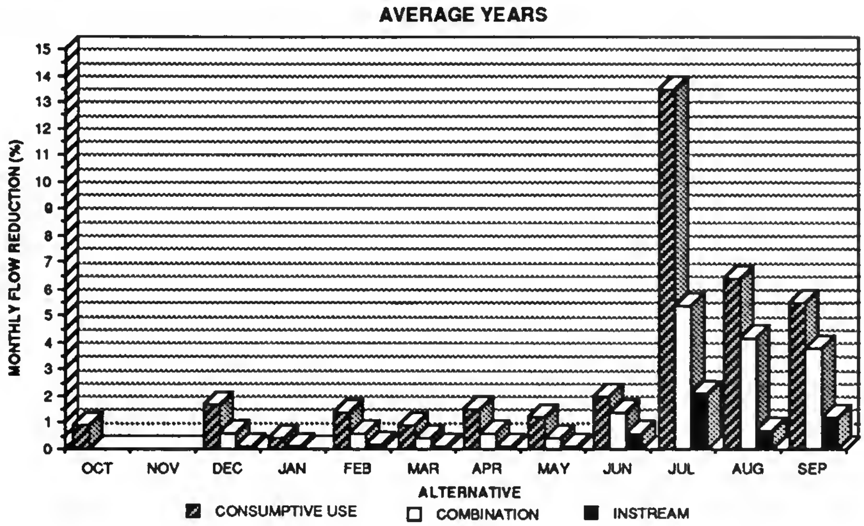
The three alternatives would cause some summer flow reductions in this reach of the Missouri River. Flow would be reduced most at Black Eagle under the Consumptive Use Alternative as shown in Figure 6-9.

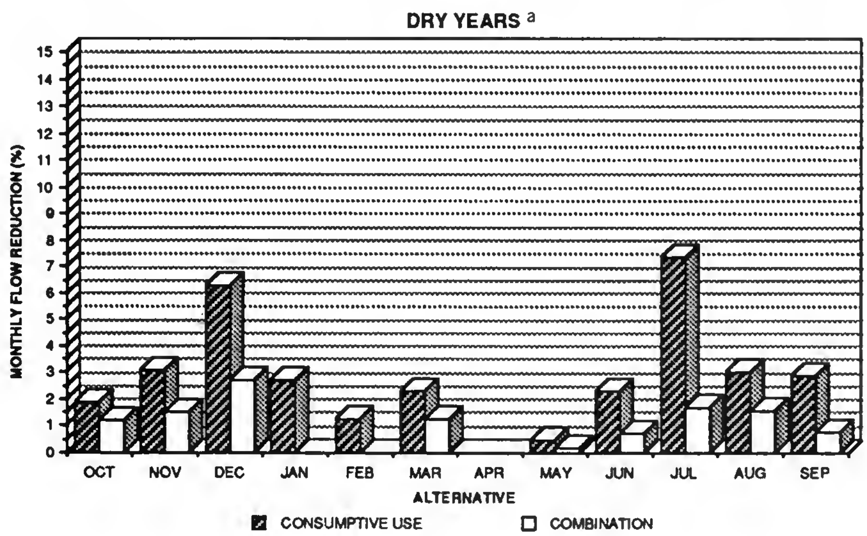
Under the Instream Alternative, flow reductions in the Missouri River and its tributaries would be small.

In the Dearborn River, flow reductions would be small and would be most pronounced in August. Average August flows in the Dearborn River near the mouth would decline 2.7 percent under the Consumptive Use and Combination alternatives.

In the Smith River above Hound Creek, July, August, and September flows would decline 4.0, 8.0, and 4.5 percent during average years and 8.8, 16.3, and 7.4 percent during dry years. In the Smith River

Figure 6-9. Monthly flow reductions in the Missouri River at Black Eagle



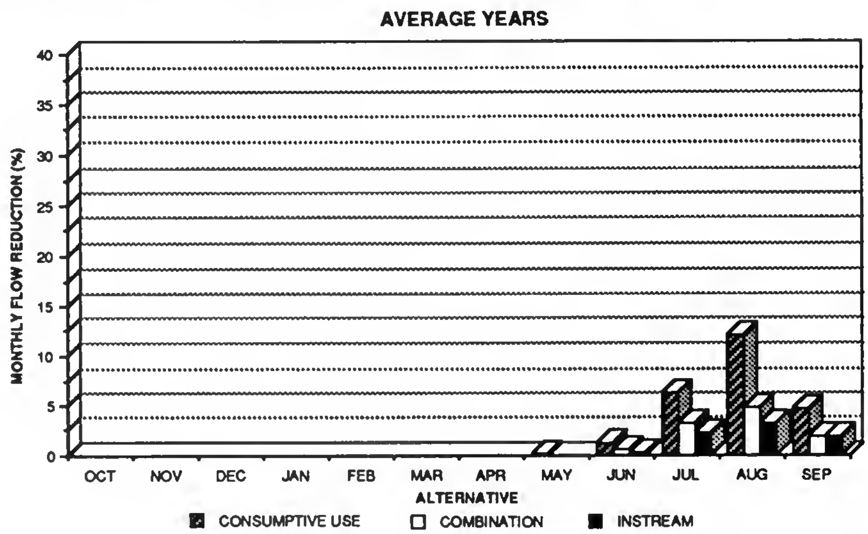


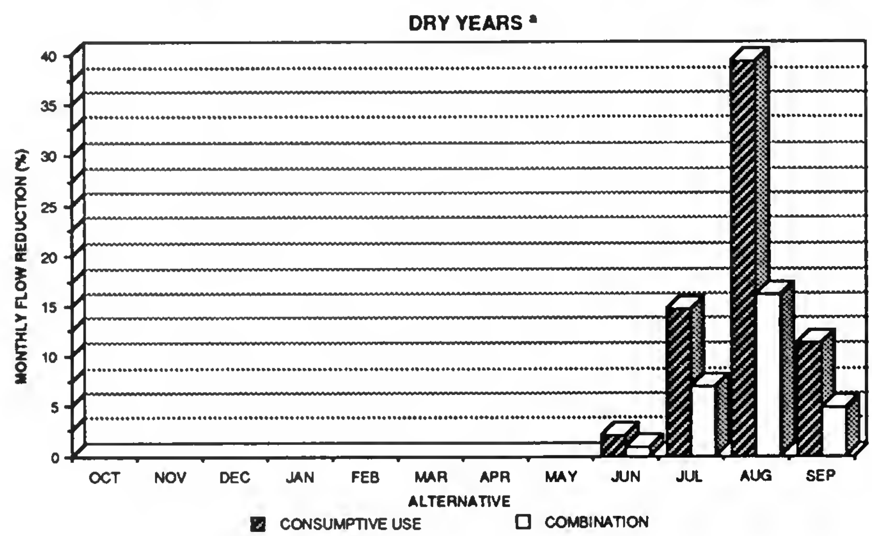
[a] No reductions would occur under the Instream Alternative during dry years.

near Eden, flow would be reduced substantially under the Consumptive Use and Combination alternatives in July, August, and September (see Figure 6-10). These impacts would be particularly severe under the Consumptive Use Alternative, which would reduce August flows 92 percent during the driest year in 10. Near the mouth of the Smith River, July, August, and September flows would decline by 9.5, 22.8, and 8.4 cfs under the Consumptive Use Alternative during average years. Flow reductions would be less under the Combination and Instream alternatives.

In the Sun River, July and August flows near Vaughn would decline substantially under the Consumptive Use and Combination Alternative (see Figure 6-11). Impacts would be particularly great under the Consumptive Use Alternative and July flows would cease near Vaughn during the driest year in 10. On the Sun River above its confluence

Figure 6-10. Monthly flow reductions in the Smith River above Hound Creek





[a] No reductions would occur under the Instream Alternative during dry years.

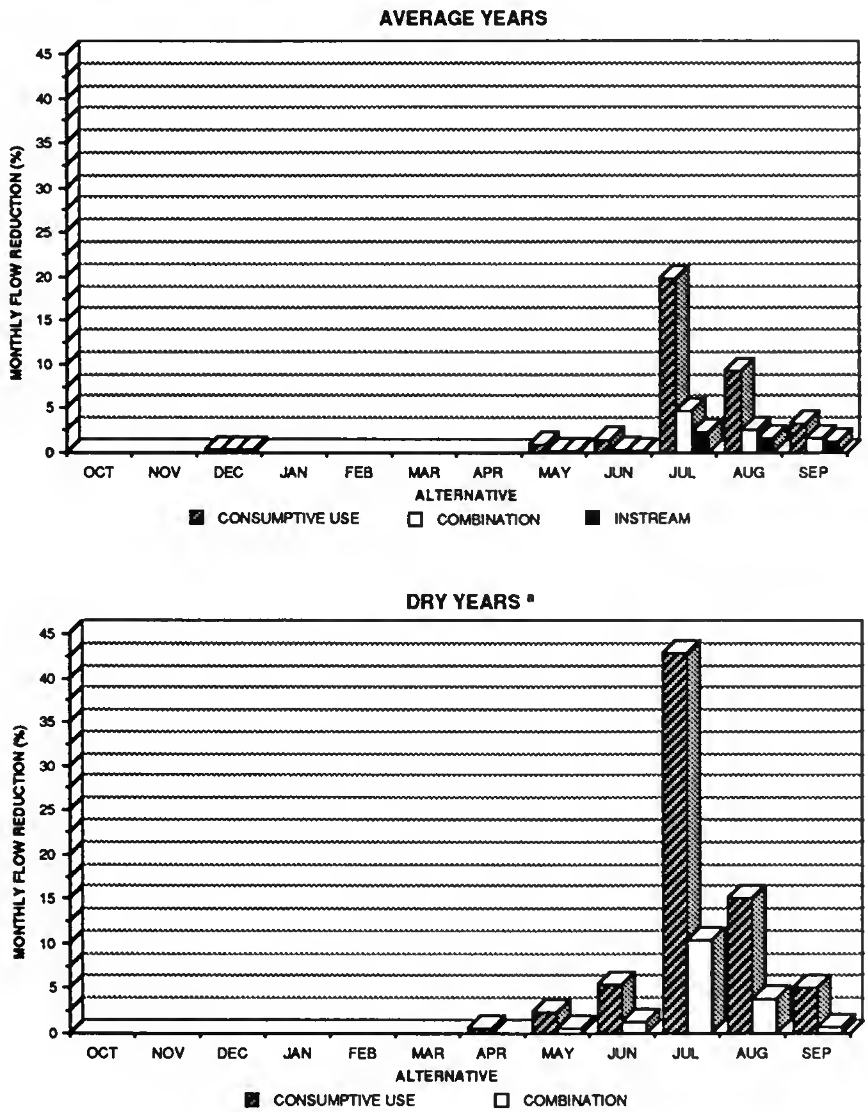
with Muddy Creek, average July and August flows at Simms would decline an estimated 3.5 and 6.8 percent under the Consumptive Use Alternative.

In the lower reaches of Belt Creek, major summer flow reductions would occur during dry years under the Consumptive Use Alternative. Average July, August, and September flows would decline 17.1, 22.0, and 10.5 percent during dry years. Under the Combination Alternative, summer flows also would be reduced in the lower reaches of Belt Creek in July, August, and September during dry years by 3.8, 4.7, and 2.1 percent. On Little Otter Creek, July, August, and September flows would decline 25.8, 23.2, and 10.6 percent under the Consumptive Use and Combination alternatives.

Marias River Drainage

August and September flows in the upper Marias River would be reduced during dry years under the

Figure 6-11. Monthly flow reductions in the Sun River near Vaughn

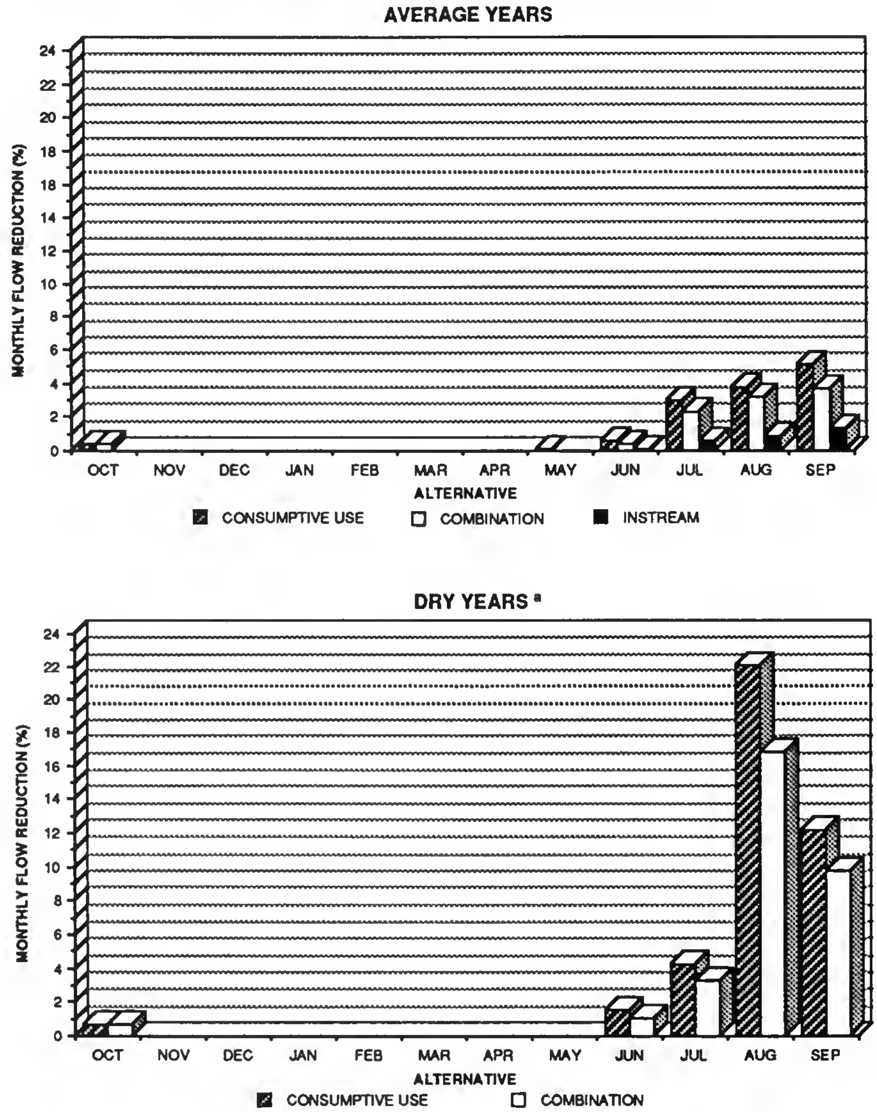


[a] No reductions would occur under the Instream Alternative during dry years.

Consumptive Use and Combination alternatives. These impacts are shown for inflows to Tiber Reservoir in Figure 6-12. Inflows and storage at Tiber Reservoir would not be affected to a major degree under the Instream Alternative. Outflows and storage at Tiber Reservoir would not be altered substantially under any of the alternatives.

The Consumptive Use Alternative would cause major reductions in lower Marias River flows during summer months of average and dry years (see Figure 6-13). Flows near Loma would cease altogether during July in the driest year out of 10. Under the Combination Alternative, summer flows in the lower Marias River would be reduced substantially during dry years. Under the Instream Alternative, average monthly flow reductions in the lower Marias River would be 1 percent or less.

Figure 6-12. Monthly flow reductions in the Marias River above Tiber Reservoir



[a] No reductions would occur under the Instream Alternative during dry years.

Summer streamflows in Marias River tributaries would be altered by proposed projects under the Consumptive Use and Combination alternatives. In particular, estimated average June, July, and August flows would decline substantially in at least three watercourses under the Consumptive Use Alternative and two streams under the Combination Alterative as shown in Table 6-2. In some cases proposed reservations are equal to or greater than estimated average monthly flows in the Marias River tributaries.

TETON RIVER DRAINAGE

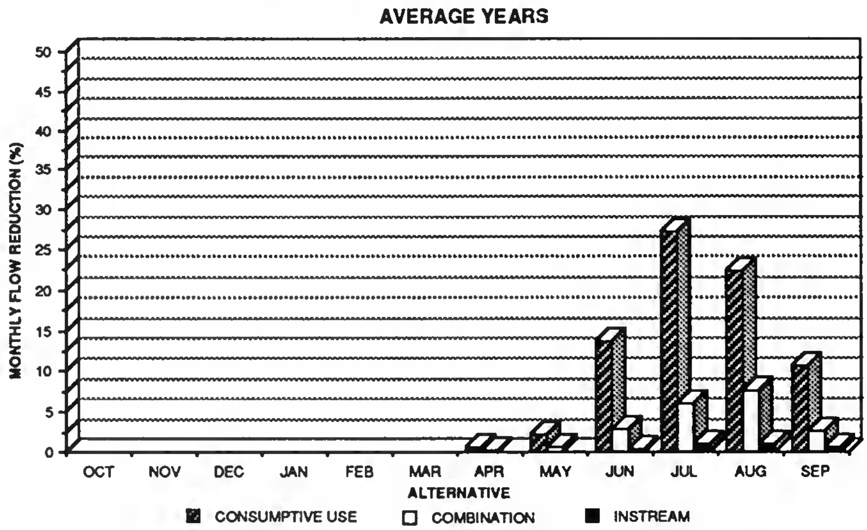
Existing flows in the Teton River are insufficient to support all water uses included in any of the three alternatives. July flows at the mouth of the Teton River near Loma already cease during the driest 2 years in 10. Flows cease in August and September of average years.

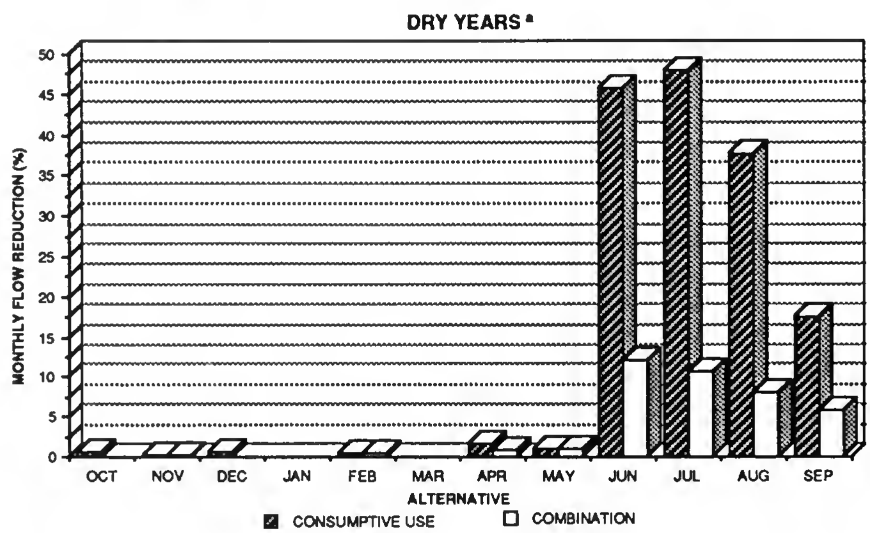
Table 6-2. Streamflow reductions in Marias River tributaries under Consumptive Use, Instream, and Combination alternatives

Watercourse	Alternative	Percent Reductions in Estimated Average Monthly Flows June	July	August
Cut Bank Creek	Consumptive Use	0.5	2.4	3.8
	Instream	0.5	2.4	3.8
	Combination	0.5	2.4	3.8
Birch Creek	Consumptive Use	0.2	0.5	0.4
	Instream	0	0	0
	Combination	0.2	0.5	0.4
Two Medicine River	Consumptive Use	0.2	1.5	3.3
	Instream	0	0	0
	Combination	0.2	1.5	3.3
Unnamed Tributary of Bullhead Creek[a]	Consumptive Use	12	24	13
	Instream	0	0	0
	Combination	12	24	13
Whitetail Creek	Consumptive Use	0.1	0.5	0.5
	Instream	0	0	0
	Combination	0.1	0.5	0.5
Dry Fork Marias River[a]	Consumptive Use	0.1	0.5	0.4
	Instream	0	0	0
	Combination	0.1	0.5	0.4
Timber Coulee	Consumptive Use	13	80	100
	Instream	0	0	0
	Combination	13	80	100
Laughlin Coulee[a]	Consumptive Use	10	58	50
	Instream	0	0	0
	Combination	0	0	0

a Flows in these streams are predicted with computer simulation techniques.

Figure 6-13. Monthly flow reductions in the Marias River near Loma



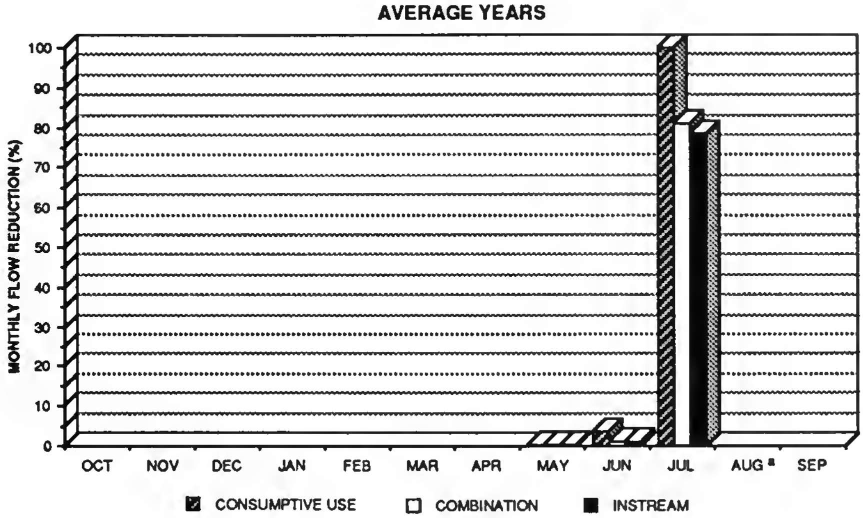


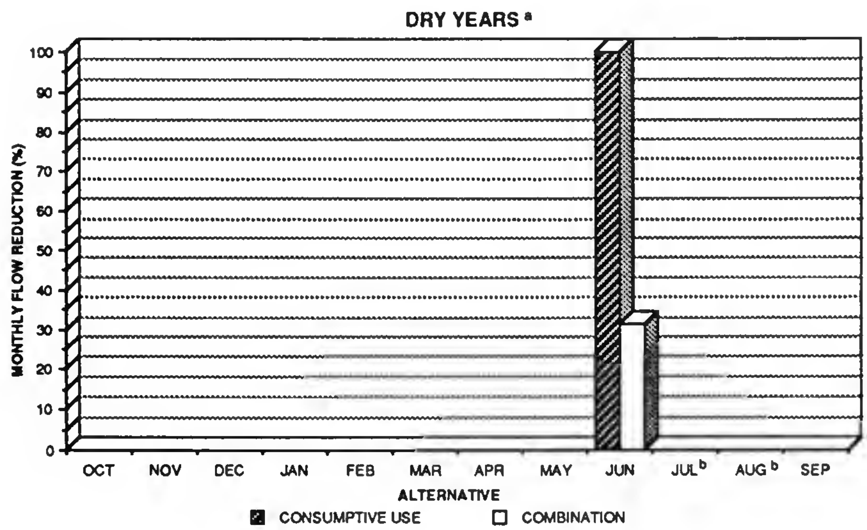
[a] Reductions under the Instream Alternative during dry years would be small.

Under the Consumptive Use Alternative, June flows would cease during dry years, July flows would cease in average years, and August flows would drop to 3 cfs during wet years. In wet years, July, August, and September flows would decrease 14.4, 92.7 and 30.5 percent. Under the Combination Alternative, August and September flows during wet years would decline 63.4 and 10.5 percent near Loma. Even under the Instream Alternative, summer flows in the Teton River would decline. Average July flows near Loma would decline substantially as shown in Figure 6-14. During wet years, August and September flows near Loma would decline 63.4 and 10.5 percent under the Instream Alternative.

Percentage flow reductions for the Teton River near Loma are depicted for all three alternatives in Figure 6-14. These graphs show that in dry years, only June flows are affected. DNRC's computer model indicates that this occurs because in the

Figure 6-14. Monthly flow reductions in the Teton River near Loma



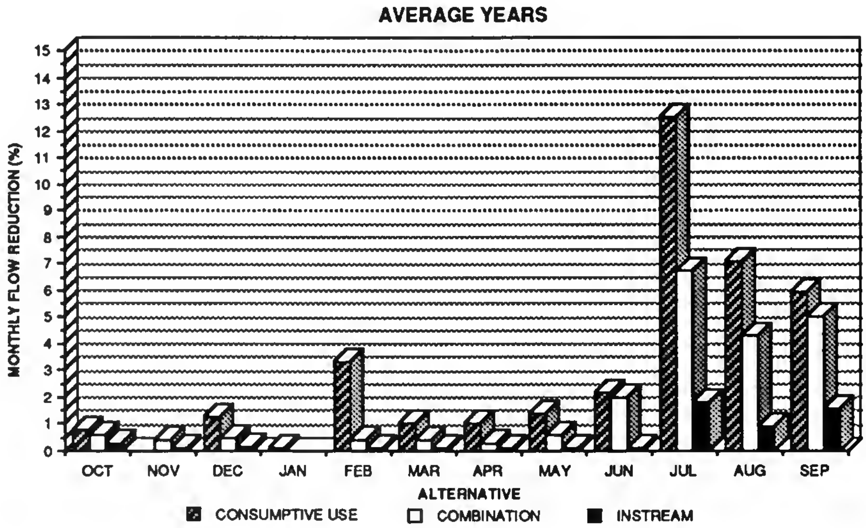


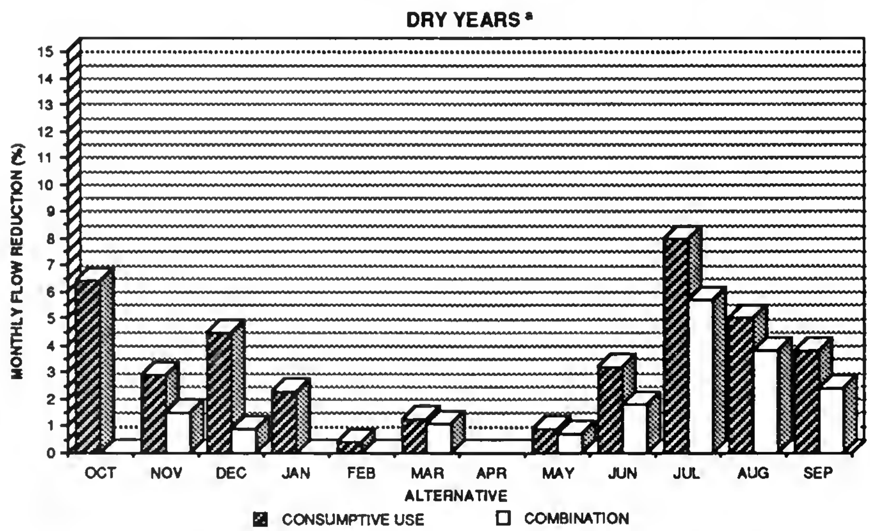
[a] No reductions would occur under the Instream Alternative during dry years.
[b] Flows in the lower Teton River now drop to zero during these months.

driest 2 years in 10, flows are zero at this location during all months except March and June. Therefore, under baseline conditions, flows simply are not available during most months in a dry year.

Tributaries of the Teton River also would be affected by proposed irrigation projects. Under the Consumptive Use Alternative, four such projects would require water storage facilities: TE-361, TE-401, TE-581, and TE-591. These storage reservoirs would be located on Spring Coulee, Gamble Coulee, and on an unnamed tributary of the Teton River. Project TE-591, on Gamble Coulee, also is included in the Instream and Combination alternatives. Each of the storage projects would store water in the spring during periods of high runoff and release water in the late summer. The projects on Gamble Coulee and the unnamed Teton tributary would substantially alter flows in these streams.

Figure 6-15. Monthly flow reductions in the Missouri River at Fort Benton





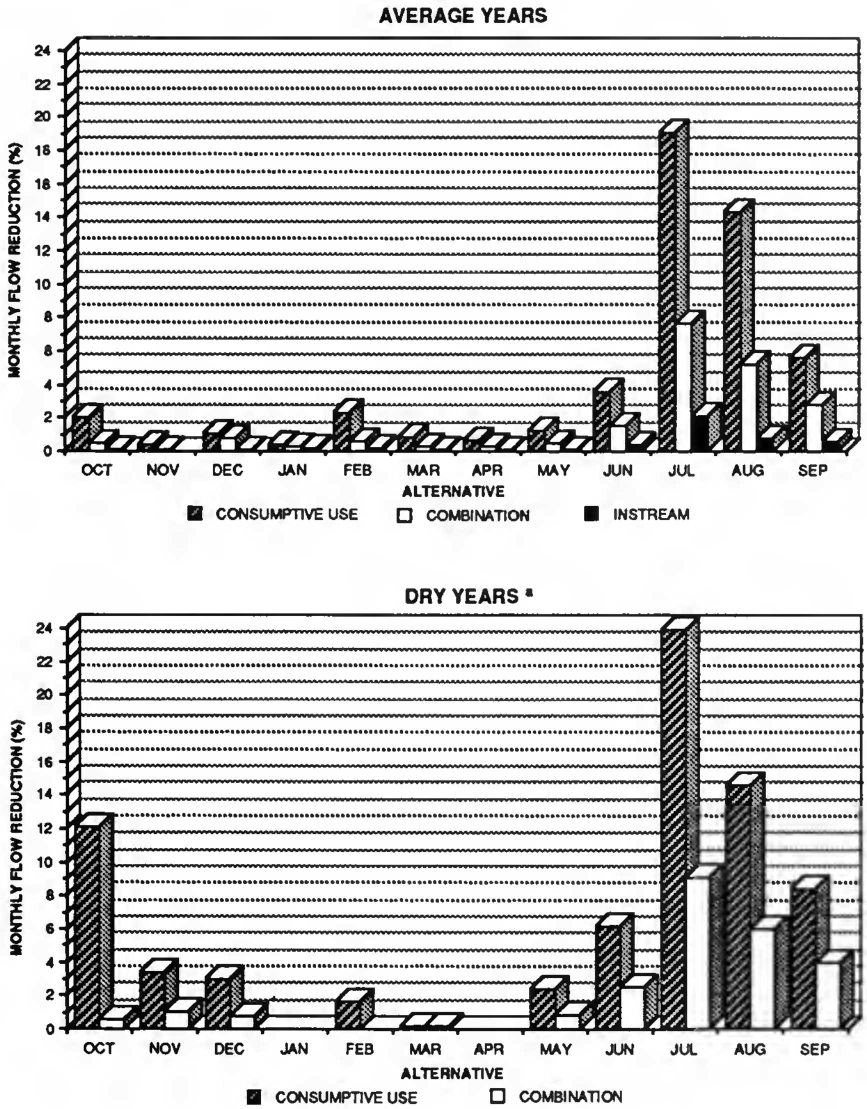
[a] Reductions under the Instream Alternative during dry years would be small.

Missouri River Drainage - Belt Creek to Fort Peck Reservoir

Under the Consumptive Use and Combination alternatives, summer flows in the Missouri River would be reduced substantially. At Fort Benton, July and August flows would decline as shown in Figure 6-15. Farther downstream at Virgelle, flows would decrease as shown in Figure 6-16. Flow reductions similar to those predicted at Virgelle would occur farther downstream near Landusky (see Figure 6-17). Flows in the Missouri River would be reduced slightly under the Instream Alternative at Fort Benton, Virgelle, and near Landusky.

Reductions in summer inflows to Fort Peck Reservoir would be greatest under the Consumptive Use Alternative. Long-term outflows from Fort Peck would decline only 3.3 percent under the Consumptive Use Alternative and 1.4 percent under the Combination Alternative. Monthly reductions in

Figure 6-16. Monthly flow reductions in the Missouri River at Virgelle



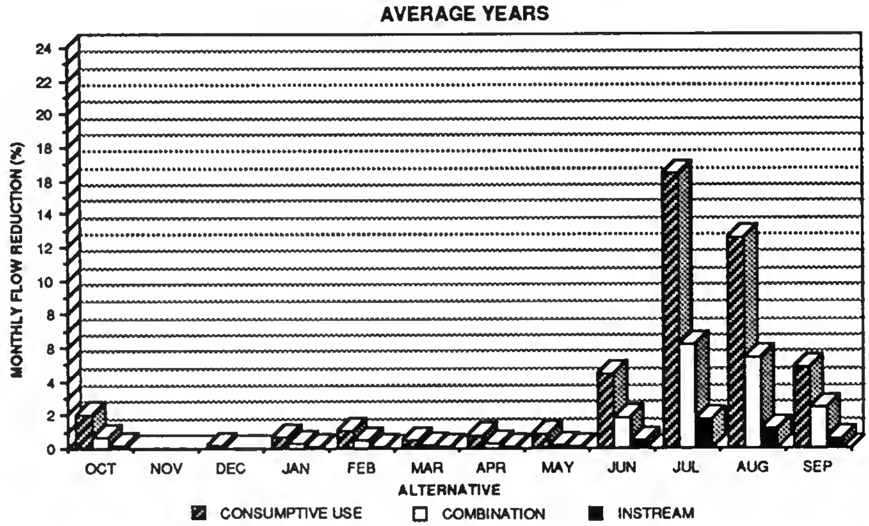
[a] Reductions under the Instream Alternative during dry years would be small.

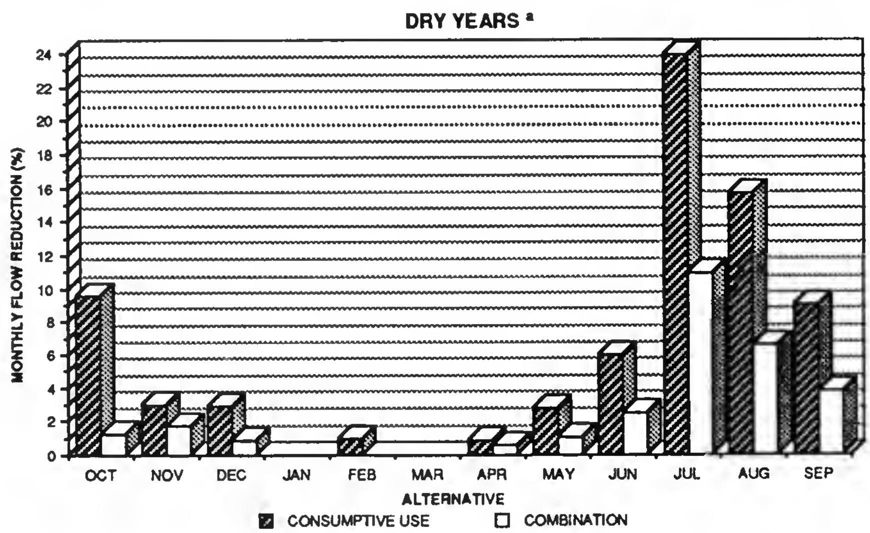
outflow from Fort Peck under the Consumptive Use and Combination alternatives would be as high as 11.8 and 6.6 percent during January of dry years.

Inflows and outflows from Fort Peck Reservoir would not decline substantially under the Instream Alternative. The long-term reduction in outflows from Fort Peck would be only 0.7 percent.

The long-term reductions in Fort Peck Reservoir volume would be 0.3 percent under the Consumptive Use Alternative, less than 0.2 percent under the Combination Alternative, and less than 0.1 percent under the Instream Alternative. Monthly reductions in reservoir contents for the three alternatives would be less than 0.7 percent, less than 0.3 percent, and below 0.1 percent during both average and dry years. These reductions would drop reservoir levels no more than 1 foot.

Figure 6-17. Monthly flow reductions in the Missouri River near Landusky





[a] Reductions under the Instream Alternative during dry years would be small.

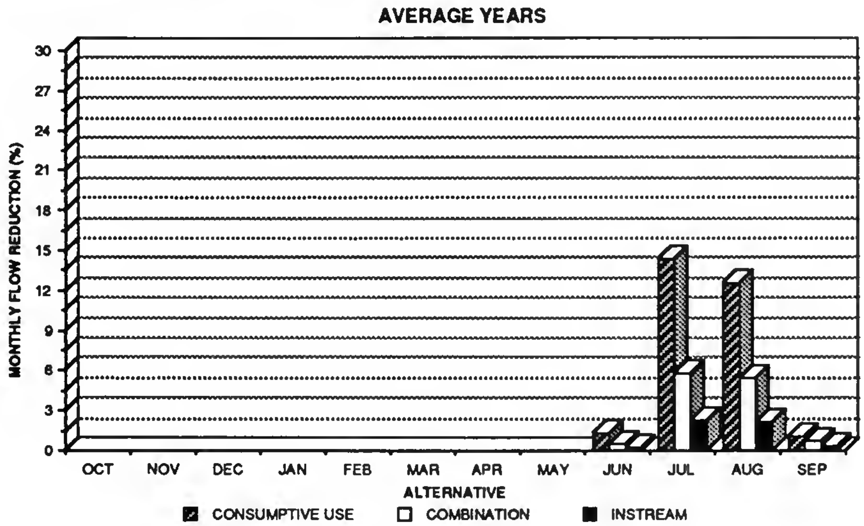
Tributaries of the Missouri River between Belt Creek and Fort Peck Reservoir would be affected under the Consumptive Use and Combination alternatives. Summer flows would be severely reduced in an unnamed spring feeding Big Sag Creek, and Shonkin Creek. The estimated average July and August flows on Shonkin Creek would decline 78 and 62 percent. On the unnamed tributary to Big Sag Creek, estimated average June, July, and August flows would decrease 50, 74, and 54 percent under the two alternatives.

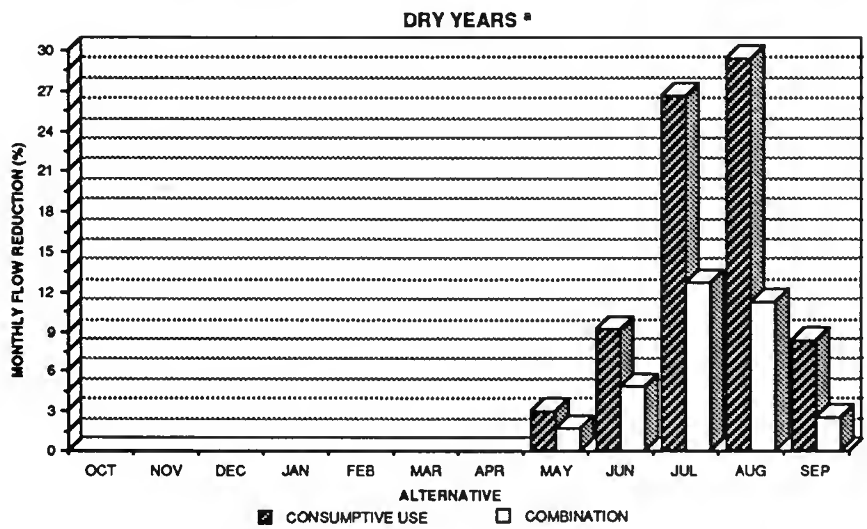
Judith River Drainage

Flows would decline substantially in the Judith River during summer months under the Consumptive Use and Combination alternatives. Figure 6-18 shows these flow reductions for the mouth of the Judith River.

Summer streamflows in Judith River tributaries could be severely altered by irrigation projects under all three alternatives. In particular, estimated average

Figure 6-18. Monthly flow reductions in the Judith River near its mouth





[a] No reductions would occur under the Instream Alternative during dry years.

June, July, and August flows would decline in at least 11 streams under the Consumptive Use Alternative and 8 under the Combination Alternative as shown in Table 6-3. Summer streamflows in Judith River tributaries also could be reduced under the Instream Alternative as shown in Table 6-3.

The impacts to Judith River tributaries would be caused by irrigation projects proposed by the Fergus County and Judith Basin conservation districts. In some cases, the proposed reservations are greater than estimated average monthly flows. For example, irrigation projects FE-42 and FE-141 would cause flows to cease during July and August on an unnamed tributary of Campbell Coulee and on Wolverine Creek. Similarly, irrigation projects JB-21, JB-231, and JB-232 would cause flows to cease on Louse Creek during July and August of average years.

Table 6-3. Streamflow reductions in Judith River tributaries under Consumptive Use, Instream, and Combination alternatives

Watercourse	Alternative	Percent Reductions in Estimated Average Monthly Flows June	July	August
Unnamed tributary of Campbell Coulee	Consumptive Use	5	100	90
	Instream	0	0	0
	Combination	0	0	0
Wolf Creek	Consumptive Use	2	19	25
	Instream	0	0	0
	Combination	0	0	0
Running Wolf Creek (spring fed)	Consumptive Use	21	72	60
	Instream	19	66	55
	Combination	21	72	60
Wolverine Creek[a]	Consumptive Use	39	100	100
	Instream	39	100	100
	Combination	39	100	100
Warm Springs Creek	Consumptive Use	4	13	11
	Instream	0	0	0
	Combination	3	11	9
Little Casino Creek	Consumptive Use	8	28	24
	Instream	8	28	24
	Combination	8	28	24
Olsen Creek (spring fed)	Consumptive Use	12	41	34
	Instream	12	41	34
	Combination	12	41	34
Unnamed tributary of Olsen Creek (spring fed)	Consumptive Use	25	85	71
	Instream	25	85	71
	Combination	25	85	71
Unnamed tributary of Ross Fork Creek (spring fed)[a]	Consumptive Use	unknown	unknown	unknown
	Instream	unknown	unknown	unknown
	Combination	unknown	unknown	unknown
Louse Creek	Consumptive Use	8	100	100
	Instream	8	100	100
	Combination	8	100	100
McCarthy Creek (spring fed)	Consumptive Use	15	49	41
	Instream	0	0	0
	Combination	15	49	41
Little Trout Creek	Consumptive Use	3	70	23
	Instream	0	0	0
	Combination	0	0	0

a Flows in these streams were predicted with computer simulation techniques.
Conversations with landowners indicate actual flows are sufficient for the proposed projects.

MUSSELSHELL RIVER DRAINAGE

The Lower Musselshell Conservation District's proposal to pump up to 8,150 acre-feet per year from abandoned underground coal mines in the vicinity of Roundup is included in the Consumptive Use Alternative. In the summer, water would be pumped from the Jeffrey Mine which is at a low elevation and close to the Musselshell River. In the spring, water from the Musselshell River would either seep naturally or be pumped back into the mine. At the time the application was developed, it was thought that this mine was connected to larger mines to the south which have the volume to store the bulk of the water requested. However, more recent data collected by the Montana Bureau of Mines and Geology show that the Jeffrey Mine is not connected to the other mines (Wheaton 1990). Thus, the project would not be feasible as proposed.

A smaller volume of water could be pumped from the Jeffrey Mine and possibly from the Republic #4 Mine to the east. Given groundwater inflows, Wheaton (1990) estimates the usable storage capacity of the Jeffrey Mine to be about 300 acre-feet. A roughly similar amount of water may be available from the nearby Republic #4 Mine, although no testing has been done to determine this. The Jeffrey Mine is connected with the Musselshell River alluvial aquifer. Pumping the mine could lower groundwater levels in this aquifer, thereby inducing infiltration of water from the Musselshell River in the mine. Thus, the streamflow augmentation provided by mine pumping during the summer would be offset to some degree by streamflow losses. Experimental pumping has shown that drawdown will occur in the adjacent aquifers when water is withdrawn from the mine.

Pumping a volume of water comparable to that requested in the applications would only be possible if it were withdrawn directly from other larger mines. Withdrawals of water from these mines also could affect surface-water flows and groundwater levels, but the extent of such effects is uncertain. However, using water from these mines would not be as economical as pumping from the Jeffrey Mine, and there are concerns regarding the quality of the water in these mines (see Water Quality Impacts section).

The reservants would pump or divert water from the Musselshell River to refill the mines in the spring. Assuming reservants could pump the requested water, average diversions would be 1,633 acre-feet in March, 2,133 acre-feet in April, and 2,991 acre-feet in May, decreasing average spring streamflows in the Musselshell River below the mine by 11 percent. Pumping from the mine would add an average of 2,697 and 3,887 acre-feet of water to the Musselshell River in July and August. This would increase streamflows directly below the mine by an average of 21 percent. However, irrigators would be able to divert this amount of water either above or below the mines, making streamflow increases or decreases at any point on the Musselshell River difficult to quantify.

Pumping water from the Jeffrey Mine or other nearby mines as proposed in Project LM-20 would lower water tables in adjacent aquifers and make several active domestic wells and possibly stock water wells temporarily unusable. The reservants may be required to replace these wells with deeper ones in the Fort Union Formation to mitigate this impact. If the water were pumped from larger volume mines, similar impacts may affect other water users. These effects would only occur under the Consumptive Use Alternative.

LEGAL WATER AVAILABILITY

IMPACTS COMMON TO THE CONSUMPTIVE USE, INSTREAM, AND COMBINATION ALTERNATIVES

STATE WATER RIGHTS - CLAIMS AND PERMITS

Reservations cannot preclude senior water right holders—those with a priority date earlier than July 1, 1985—from using water to the extent of their existing rights. If senior water right holders are concerned that any reservations(s) may affect their existing rights, they can object during the contested case hearing. The Board will use the findings of the contested case hearing when reaching its decision on the reservation applications (see Chapter 1 for a discussion of the contested case hearing).

For the purposes of this draft EIS, DNRC identified some areas where there has been conflict between new appropriators and existing water right holders. DNRC searched the water rights data base to identify streams where reservations are proposed and where existing water right holders filed objections-to applications for water use permits between July 1, 1983, and November 1989. The results of this analysis, which also include objections to groundwater wells, are summarized in Table 6-4. DNRC's staff at water rights field offices in Bozeman, Lewistown, Havre, and Helena identified streams and groundwater sources where there are problems and concerns regarding water allocations (Table 6-5).

Table 6-4. Streams where reservations are applied for and where water right holders objected to permit applications between July 1, 1973, and November 1989 (includes objections to wells)

Subbasin-Drainage	Source	Number of Permit Applications Objected to	Type of Reservations Requested: Irrigation	Municipal	Instream
Headwaters					
Gallatin River	Baker Creek	1			X
	Big Bear Creek	2			X
	Bridger Creek	1			X
	East Gallatin River	5	X		X
	Hell Roaring Creek	1			X
	Hyalite Creek	5			X
	Reese Creek	1			X
	Rocky Creek	1			X
	Sourdough Creek	2		X	X
	South Cottonwood Creek	1			X
	West Gallatin River	11	X		X
	Wells	44	X	X	X
Madison River	Blaine Spring Creek	7			X
	Cherry Creek	2			X
	Hot Springs Creek	1			X
	Madison River	7	X		X
	Moore Creek	1			X
Jefferson River	Boulder River	6	X		X
	Jefferson River	5	X	X	X
	Little Boulder River	1			X
	North Willow Creek	4			X
	Willow Spring Creek	1			X
	Wells	20	X	X	
Big Hole River	Big Hole River	11			X
	Pintlar Creek	1			X
	Rock Creek	1			X
	Willow Creek	1			X
Ruby River	Mill Creek	1			X
	Ruby River	4			X
	Wisconsin Creek	3			X
Beaverhead /Red Rock rivers	Beaverhead River	3		X	X
	Blacktail Deer Creek	1			X
	Hell Roaring Creek	1			X
	Hoarse Prairie Creek	8			X
	Red Rock River	4			X
	Wells	25		X	
Upper Missouri					
Missouri River - above Holter Dam	Confederate Gulch	11			X
	Crow Creek	2	X		X
	Deep Creek	1	X		X
	Missouri River	24	X		X
	Prickly Pear Creek	9		X	X
	Silver Creek	3			X
	Sixteenmile Creek	3			X
	Spokane Creek	1			X
	Trout Creek	7			X
	Wells	66	X	X	

Table 6-4 (continued)

Subbasin-Drainage	Source	Number of Permit Applications Objected to	Type of Reservations Requested Irrigation	Municipal	Instream
Missouri River - Holter Dam to Belt Creek	Canyon Creek	1			X
	Little Prickly Pear Creek	1			X
	Missouri River	107	X		X
	Sheep Creek	1			X
	Wolf Creek	9			X
Dearborn River	Dearborn River	5	X		X
Smith River	Newlan Creek	1			X
	Smith River	12	X		X
	N. Fork Smith River	9			X
Sun River	Big Coulee	3	X		
	Elk Creek	2	X		X
	Fork Creek	1			X
	Muddy Creek	4	X	X	
	Sun River	49	X	X	X
	Wells	16		X	
Belt Creek	Belt Creek	6	X		X
Marias/Teton					
Marias River	Cut Bank Creek	8	X		X
	Badger Creek	1			X
	Birch Creek	7	X		X
	Dupuyer Creek	1			X
	Laughlin Coulee	1	X		
	Two Medicine River	3	X		
	Whitetail Creek	1	X		
	Timber Coulee	1	X		
	Wells	1		X	
Teton River	Muddy Creek	2	X		
	Spring Coulee	7	X		
	Teton River	13	X	X	X
	Wells	20	X	X	
Middle Missouri					
Missouri River - Belt Creek to Fort Peck Reservoir	Highwood Creek	3	X		X
Judith River	Beaver Creek	1			X
	Big Spring Creek	7	X	X	X
	EF Big Spring Creek	2	X		X
	Louse Creek	2	X		
	Ross Fork Creek	7	X		
	Running Wolf Creek	1	X		
	Warm Spring Creek	5	X		X
	Wolf Creek	8	X		
	Wells	8	X	X	
Musselshell River	American Fork Creek	3			X
	Big Elk Creek	1			X
	Careless Creek	2			X
	Flatwillow Creek	7			X
	Musselshell River (Upper)	12	X		X
	Musselshell River (Lower)	10			X
	Swimming Woman Creek	1			X
Fort Peck Reservoir	Big Dry Creek	3			X
	Little Dry Creek	4			X

Table 6-5. Water sources where reservations are requested and where DNRC field office staff have noted past water allocation problems or concerns

Drainage/Subbasin	Source	Type of Reservations Requested Irrigation	Municipal	Instream
Headwaters				
Gallatin River	Baker Creek			X
	Gallatin River (middle portion)	X		X
	Gallatin Valley Groundwater	X	X	
Madison River	Blaine Spring Creek			X
	North Meadow Creek			X
Jefferson River	Boulder River	X		X
	Boulder-Valley Groundwater	X		
	Jefferson River	X	X	X
	Willow Creek			X
	South Willow Creek			X
Big Hole River	Big Hole River			X
	Swamp Creek			X
Beaverhead River	Beaverhead River		X	X
	Horse Prairie Creek			X
	Trapper Creek			X
Upper Missouri				
Missouri River - Three Forks to Holter	Deep Creek	X		X
	Prickly Pear Creek		X	X
	Silver Creek			X
	Trout Creek			X
Smith River	Smith River	X		X
Sun River	Elk Creek	X		X
	Sun River	X		X
Belt Creek	Belt Creek	X		X
Marias/Teton				
Marias River	Badger Creek			X
	Birch Creek	X		X
	Cut Bank Creek	X	X	X
Teton River	Big Coulee	X		
	Teton	X		X
	Spring Creek	X		X
	Teton Valley Groundwater	X	X	
Middle Missouri				
Judith River	Warm Springs Creek	X		X
	Wolf Creek	X		
Musselshell River	Flatwillow Creek			X
	Musselshell River	X		X

The information above only serves to identify some areas where questions may arise regarding legal water availability for reservations. It does not mean that there are no other water sources where concerns may arise, or that water cannot be reserved from the streams and aquifers identified in the tables. These questions will not be answered until the contested case hearing is complete.

Permits issued between July 1, 1985, and the date the Board reaches its decision would be junior to reservations. However, the Board may subordinate the reservations to these permits if it finds that they would not unreasonably interfere with the intent of the reservation (see Chapter Two). Appendix A lists permits and permit applications that have a priority date between July 1, 1985, and May 1, 1990, when DNRC last analyzed water permits and applications in the basin for the purposes of this EIS.

If the Board grants reservations, the reserved water will not be available for new appropriation because it will be committed either for consumptive use (see Impacts to Water Quantity and Distribution), or for instream flow. However, DNRC, with approval of the Board, may issue a temporary permit to use water reserved for consumptive use until the reservant needs the water. The amounts of water that would be unavailable for appropriation on the average if all instream requests are granted are presented in Appendix I. Granting reservations for consumptive use also would reduce water available for appropriation (see Water Quantity and Distribution Section).

Reservations would give reservants legal standing to object to changes in senior and junior water rights and applications for new permits, and the right to participate in the adjudication process.

MPC AND BUREC CLAIMS

BUREC claims water rights for a variety of uses at Canyon Ferry Reservoir, and MPC claims rights for storage and power generation at Hauser and Holter dams. Water quantities at these facilities already are often below the amounts claimed and the additional consumptive use development in the three alternatives would result in further reductions. MPC also operates five hydroelectric dams on the Missouri River in the vicinity of Great Falls. At all of these facilities, flows sometimes drop below those claimed by MPC for power production, and the additional consumptive use development would result in further flow reductions with subsequent reductions in hydroelectricity production. The reductions and resulting impacts would be greatest under the Consumptive Use Alternative, intermediate under the Combination Alternative, and least under the Instream Alternative. MPC objects to almost all new permit applications in the basin above Great Falls on the basis that they would adversely affect its prior rights.

As noted in Chapter Four, Canyon Ferry Dam was built in the 1950s so new irrigation development could occur in the basin above Great Falls without affecting MPC's power production at its seven mainstem Missouri River facilities. In 1955, before Canyon Ferry Dam was constructed, MPC was producing annually an average of 1,884 gigawatt hours (billion watt hours - GWh) of electricity. With Canyon Ferry Reservoir in place, power production rose to about 1,990 GWh annually. MPC pays BUREC for this difference in power generation (106 GWh) referred to as headwater benefits. Consumptive uses developed between 1955 and 1986 have dropped average annual power production to 1,968 GWh annually and decreased headwater benefits by 22 GWh. This consumptive use resulted in no headwater benefits in the 2 lowest power producing years in 10 (refer to Table 4-12). Under the Consumptive Use Alternative, headwater benefits would drop 46 percent below those in 1955 and 31 percent below the 1986 levels. Under the Combination Alternative, headwater benefits would drop 33 percent below the 1955 level and 16 percent below the 1986 level. Decreases to headwater benefits under the Instream Alternative would be small. Reductions in headwater benefits under the Consumptive Use and Combination alternatives are summarized in Table 6-6.

FORT PECK RESERVOIR

Consumptive use of water, as proposed to various extents in all the alternatives, would make less water available to satisfy Army Corps of Engineers' claims for power production at Fort Peck Reservoir. The amounts of water used and thereby made unavailable to the Corps for power generation would be greatest under the Consumptive Use Alternative, less under the Combination Alternative, and least under the Instream Alternative. However, the Corps has not objected to the issuance of water use permits upstream of the dam.

MURPHY RIGHTS

At times, summer streamflows are already lower than DFWP's Murphy right claims on the following streams where reservations for new consumptive

Table 6-6. Decreases in Canyon Ferry Reservoir headwater benefits to hydropower production at MPC's seven mainstem Missouri dams under the Consumptive Use and Combination alternatives (annual GWh)

Frequency of occurrence	A Headwater benefits under existing conditions (1986 level of irrigation development)	B Headwaters benefits under the Consumptive Use Alternative	C Headwater benefits under the Combination Alternative	D Reductions to headwater benefits under the Consumptive Use Alternative (Col. A – Col. B)	E Reductions to headwater benefits under the Combination Alternative (Col. A – Col. C)
1 year in 10	157	145	154	12	3
2 years in 10	115	101	108	14	7
5 years in 10	84	37	67	47	17
8 years in 10	-1	-16	-9	15	8
9 years in 10	-25	-61	-29	36	4
Average	84	58	71	26	13

uses are proposed: the Madison River below Ennis Lake, the Gallatin River from the junction of the East Gallatin River to its mouth, the Missouri River from Toston to Canyon Ferry Reservoir, and the Smith River from the Fort Logan Bridge to the confluence with Hound Creek. Development of consumptive use projects would cause flows to drop further below those claimed by DFWP on these streams. These effects would be greatest under the Consumptive Use Alternative, less under the Combination Alternative, and least under the Instream Alternative. DFWP also has applied to reserve instream flows on all these stream reaches.

Federal Reserved Rights

Indian Tribes

Projects POI-10, PO-421, PO-171, GL-11, GL-221, and GL-201, as included under the Consumptive Use and Combination alternatives, are on deeded land on the Blackfeet Indian Reservation and would divert water from Birch, Cut Bank, and Whitetail creeks and the Two Medicine River. Project PO-251 and the City of Cut Bank also would divert water from Birch and Cut Bank creeks where those streams border reservation land. The Instream Alternative includes projects GA-11 and GL-221, and a reservation for the City of Cut Bank. The Blackfeet Tribes claim reserved rights for all these streams, and existing flows are often well below those claimed by the Tribes on Cut Bank, Badger, and Birch creeks and the Two Medicine River (see Table 4-15). The water reservations would be junior to the Tribes' rights, and senior tribal water users could preclude reservants from diverting water when flows are low.

The tribes of the Turtle Mountain Reservation in North Dakota control scattered parcels of land in the basin. Among these holdings are 1,120 acres on project BSS-2, which is included in the Consumptive Use Alternative. Because it is not known what the reserved water rights are for these parcels, reserving water for them could result in duplicating irrigation water rights for these lands.

Under the Consumptive Use and Combination alternatives, BUREC would divert water from the Missouri River at Virgelle for use in the Milk River drainage. Some of the water diverted into the Milk River would be used to satisfy reserved water rights for the tribes of the Rocky Boy and Fort Belknap reservations.

Federal Agencies

The U.S. Forest Service, Bureau of Land Management, Fish and Wildlife Service, and National Park Service all claim federal reserved rights in the basin. Because most reserved rights for the U.S. Forest Service and National Park Service would be for flows in headwaters streams, it is unlikely there would be conflicts with the proposed new consumptive uses, most of which would be at lower elevations. One exception would be Bozeman's proposal to

construct a reservoir on Sourdough Creek, a stream that flows through National Forest land. Forest Service approval would be necessary before this project could be developed. U.S. Fish and Wildlife Service holdings with reserved rights are upstream from the proposed reservations and therefore would not be adversely affected.

BLM claims a federal reserved water right with a 1976 priority date for flows in the wild and scenic section of the Missouri River (from Fort Benton to the Fred Robinson Bridge). During dry years, flows in this section of the river already drop lower than those that BLM considers desirable (see Table 4-16). The consumptive water uses included in the Consumptive Use and Combination alternatives would reduce flows further. Reductions of flow and any resulting impacts would be greatest under the Consumptive Use Alternative, less under the Combination Alternative, and least under the Instream Alternative (see Figures 6-15 to 6-17).

Impacts to Other Reservants

The amount of water used by the municipalities, which are given first priority under all alternatives, would be relatively small and probably would not have much effect on the legal availability of water for other reservants. The potential for conflict is greater between consumptive uses and instream requests on streams where not enough water is available for both irrigation projects and instream flows. Granting of reservations for irrigation ahead of proposed instream reservations, as in the Combination and Consumptive Use alternatives, would reduce streamflows available for instream reservations. On the other hand, granting instream reservations with priority higher than proposed irrigation reservations, as in the Instream Alternative, would result in no water being available for irrigation projects during dry years, except for project VAS-1.

STORAGE

Fifteen storage projects are included in the reservation applications as summarized in Table 6-7. Of these, the City of Bozeman's proposed 6,000 acre-foot reservoir on Sourdough Creek is the largest. The total volume stored by all 15 projects would be 9,357 acre-feet under the Consumptive Use Alternative, 7,490 acre-feet under the Combination Alternative, and 7,117 acre-feet under the Instream Alternative. This increase in volume is small in comparison to the estimated 26 million acre-feet presently stored in the basin.

Reservations would make some water unavailable for future storage. However, reservations generally would not preclude the storage of spring runoff flows. A case-by-case analysis would be necessary to determine the amount of water available for a specific storage project. Appendices C and I provide an indication of the amount of water that would be available for storage. Overall, these amounts would be similar under the three alternatives. In general, new storage projects would probably require larger storage capacity to obtain a given firm yield with the reservations in place than without them.

Table 6-7. Proposed storage projects (capacities in acre-feet)

Stream	Consumptive Use	Instream	Combination	Purpose
Sourdough Creek				
Bozeman	6,000	6,000	6,000	Municipal
Cut Bank Creek				
Cut Bank	400	400	400	Municipal
Teton River				
TE-361	288	—[a]	—[a]	Irrigation
TE-591	2,236	2,236	2,236	Irrigation
TE-401	263	—	—	Irrigation
TE-581	113	—	—	Irrigation and fish and wildlife
CH-381	513	—	—	Irrigation
Marias River				
TO-421	112	—	112	Irrigation
PO-91	127	—	—	Irrigation
Teton/Alkali Coulee				
CH-641	53	53	53	Wildlife
Cut Bank Coulee				
CHFG-181	38	38	38	Fire protection and recreation
Judith River				
FE-81	403	—	—	Irrigation
FE-161	375	375	375	Irrigation
FE-161	261	—	261	Irrigation
Unnamed tributary - Smith Creek				
LC-251	160	—	—	Irrigation
TOTAL	11,342	9,102	9,475	

[a] Blank space indicates a project is not included in that alternative.

Reservations also would affect benefits from existing storage projects. The three alternatives would lower water levels in Canyon Ferry, Tiber, and Fort Peck reservoirs under the present regime of reservoir operation. Annual hydropower generation would decrease at all main-stem hydropower facilities (refer to section on hydropower) and recreation would be affected, primarily at Canyon Ferry, Tiber, and Fort Peck (refer to section on recreation). Impacts to existing storage would be greatest under the Consumptive Use Alternative, less under the Combination Alternative, and least with the Instream Alternative.

WATER QUALITY

General Impacts and Considerations

Reservations for irrigation projects would reduce flows during the summer when some streams are already low due to existing uses and natural conditions. Diversions during low-flow periods generally reduce water quality by decreasing the amount of water available to dilute contaminants. Reduced summer flows can elevate stream temperature. Water quality is further affected by irrigation return flows which may carry nutrients and pesticides into streams or aquifers. Leaching and water use by crops can increase salt concentrations in return flows and receiving streams. Figures 6-19 and 6-20 compare TDS concentrations to Montana standards under existing conditions and to those that would occur under the Consumptive Use and Combination alternatives on selected streams. Except where otherwise noted, all proposed projects together would have only minor effects on TDS concentrations in the Missouri River and its tributaries.

Construction of reservoirs and diversion structures could lead to short-term sediment increases when streambeds are disturbed. Construction that disturbs a stream channel would require the reservant to comply with the provisions of the Natural Streambed and Land Preservation Act (SB 310) and could require a permit from the Army Corps of Engineers under Section 404 of the federal Clean Water Act.

Arsenic

Arsenic that originates in Yellowstone National Park is present in high concentrations in the Madison and Missouri rivers. According to EPA, for every one $\mu g/L$ rise in arsenic the risk of cancer increases by 50 cases per million people. Based on this information and average concentrations, the existing cancer risk is about 1 case of cancer for every 274 people at Ennis and 1 case of cancer for every 666 people at Toston. These estimates are based on the assumption that people are drinking about 2 liters of untreated Madison-Missouri River water daily for

Figure 6-19. TDS increases under the Consumptive Use Alternative

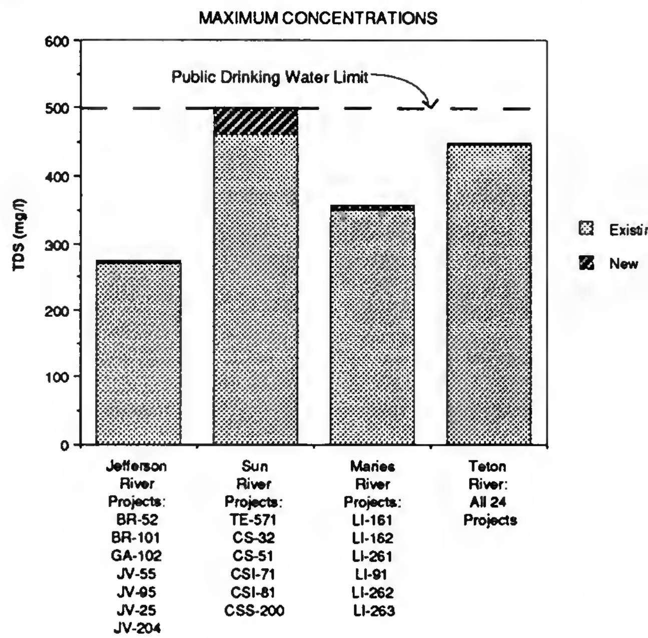
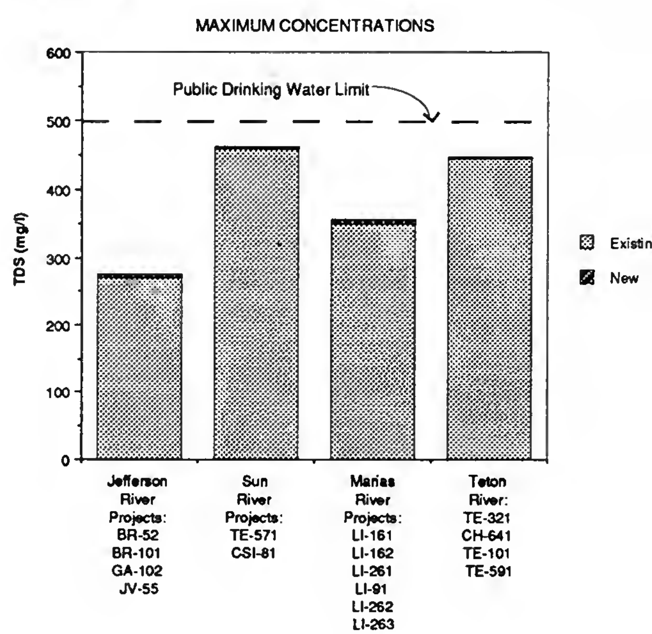


Figure 6-20. TDS increases under the Combination Alternative



most of their lives. All consumptive use projects included in the three alternatives could increase arsenic concentrations in surface water and groundwater.

Water in the Madison and Missouri rivers contains arsenic at relatively high concentrations and irrigating with this water, as proposed in the three alternatives, would contaminate shallow aquifers under the projects and might affect wells. An investigation by Sonderregger et al. (1989) shows that irrigation with arsenic-laden Madison River water has contaminated shallow aquifers underlying the Madison valley. Arsenic concentrations as high as 130 µg/L have been recorded in these aquifers and arsenic has contaminated wells used for drinking water. Use of Missouri and Madison river water for irrigation would result in evaporation and water use by plants. This could concentrate arsenic in return flows which in turn would increase the arsenic concentration in the Missouri River. Appendix J lists projects that might cause these effects.

Projects that deplete flows in tributaries would reduce the amount of water available to dilute already high arsenic concentrations in the Missouri River. Appendix J also lists projects that would reduce tributary flows into the Missouri River.

In some instances, diverting water from the Missouri and Madison rivers for consumptive use could add arsenic to other drainages where arsenic concentrations are much lower. These effects are described in more detail in discussions for each subbasin.

Under the three alternatives, people in communities that use Missouri River water would face an increased risk of developing skin cancer from drinking water with elevated arsenic concentrations unless public water supplies could be treated to offset arsenic increases (Table 6-8). This risk would be greatest under the Consumptive Use Alternative, less under the Combination Alternative, and least under the Instream Alternative.

Table 6-8. Municipalities in the Missouri River Basin above Fort Peck using Missouri River water that would contain elevated arsenic levels as a result of reservations

Municipalities	Source[a]	Population Served[b,c]
Three Forks	GW	1,180
Townsend	GW	1,600
Bureau of Reclamation - Canyon Ferry	SW	100
Helena	SW	12,000[d]
Great Falls	SW	72,000
Carter	SW	220
Fort Benton	GW/SW	1,675
Fort Peck	SW	500

a GW = groundwater in aquifer connected to the Missouri River
SW = Missouri River water
b From DHES files
c Users of well water also could be affected
d Average population served by the Missouri River supply (city also uses other water sources)

Nutrients and Pesticides

Pesticides and soluble fertilizer components such as nitrate, nitrogen, and phosphorous can percolate into groundwater that eventually flows to streams. Intermittent-move sprinkler systems and flood systems are more likely to cause contamination than continuous-moving systems such as center pivots that can be adjusted to apply water more efficiently to soils. Pesticides resist chemical decomposition and have little capacity to bind with soil organic matter. Because fertilizers and pesticides are commonly used on agricultural crops, many of the proposed irrigation projects have the potential to contribute nutrients and pesticides to shallow groundwater and nearby streams.

Projects on gravel benches with thin, permeable soils over shallow aquifers are most likely to contribute pesticides and nutrients to the water table and eventually to surface water. Such effects also are likely for projects where thin soils are underlain by impermeable bedrock. Table 6-9 lists projects where DNRC's analysis indicates nutrient and pesticide contamination may occur. Careful application of water with sprinkler irrigation systems would minimize nutrient and pesticide contamination.

Dissolved oxygen levels can be reduced when nutrients are added to a stream, pond, lake, or reservoir. These effects would be greatest on streams where temperatures are high and streamflows and dissolved oxygen levels are already low. Adequate information is not available to determine all streams where such impacts might occur as a result of reservations. Instead, DNRC compiled a list of streams

where low flows are already a problem, and proposed reservations could increase water temperatures and decrease dissolved oxygen (Table 6-10). Dissolved oxygen levels may already be low on some of these streams, and nutrients from the proposed projects could worsen existing problems. Temperatures also might rise on these streams as flows are reduced. High water temperatures would further reduce dissolved oxygen which becomes less soluble as water warms.

Instream Reservations

Instream reservations would not change the existing water quality, but would limit further flow depletions, thereby helping to prevent increases in water temperatures and lower dissolved oxygen levels, especially during low-flow periods. Water left instream helps to dilute discharges of acid and toxic metals from operating or abandoned mines (such as in the upper Wise River drainage, Boulder River, Belt Creek, and Grasshopper Creek). Instream flow reservations also would help maintain streams' ability to dilute pollutants and to protect holders of wastewater discharge permits from added treatment costs.

Headwaters Subbasin

The Madison River has natural arsenic concentrations that exceed water quality standards (USGS 1987). Water quality investigations by Sonderegger and others (1989) have identified arsenic contamination of groundwater in areas irrigated with Madison River water. Under the Consumptive Use and Combination alternatives, additional contamination of aquifers would occur in portions of the lower Gallatin basin that would be irrigated with water from the Madison River. Madison River water with

Table 6-9. Projects with potential to cause nutrient and pesticide contamination

	Gallatin	Jefferson/ Boulder rivers	Missouri River - Three Forks to Holter Dam	Missouri River - Holter Dam to Belt Creek	Smith River	Sun River	Belt Creek	Marias River	Teton River	Missouri River - Belt Creek to Fort Peck Reservoir	Judith River
Consumptive Use Alternative	GA-13 GA-14 GA-35 GA-79 GA-81 GA-44 GA-46 GA-124 GA-143	JV-201 JV-202 JV-203 JV-95 JV-17 JV-18 BR-101	BR-38 BR-34 BR-104 BR-103 LC-11	CS-541 CSI-103 CSI-12 CSI-41 LC-210 CSI-82 CSI-83 CSI-92 CSI-91	CSI-111 CSI-120 CS-68	CS-31 CS-51 CS-32 CSI-81 TEI-80 TEI-100 TEI-571	CS-42 CS-44	LI-161 LI-162 LI-263 TO-221 CHI-52 LI- 262 LI- 261 LI-91 GL-201	TE-321 TEI-40 TE-411 TE-281 TE-282	CHS-3 CHS-5 CHS-6 CH-541	FEI-50 FEI-40 FE-671 FE-672 FE-673
Instream Alternative	None	None	BR-38 BR-34	CS-541 CSI-103 CSI-12 CSI-41 CSI-82 CSI-83 CSI-92	CSI-11	CSI-81 TEI-571	None	LI-161 LI-162	TE-321	None	FE-671 FE-672 FE-673
Combination Alternative	GA-79 GA-46 FA-143 GA-44 GA-124	BR-101	None	CS-541 CSI-103 CSI-12 CSI-41 CSI-82 CSI-83 CSI-92 CSI-91	CSI-111 CSI-120 CS-63	CSI-81 TEI-571	CS-42 CS-47	LI-161 LI-162 LI-268 TO-221 CHI-52 LI-262 LI-261 LI-91 GL-201	TE-321	CHS-3 CHS-5 CHS-6	FEI-40 FE-671 FE-572 FE-673

Table 6-10. Requested consumptive use reservations that might damage aquatic life by increasing water temperatures and decreasing dissolved oxygen under the different alternatives

Subbasin/Streams	Consumptive Use Alternative	Instream Alternative	Combination Alternative
Headwaters Subbasin			
East Gallatin River	GA-40	None	GA-41
	GA-41		GA-79
	GA-79		GA-46
	GA-24		GA-143
	GA-46		GA-44
	GA-13		GA-151
	GA-143		GA-124
	GA-44		GA-14
	GA-151		GA-35
	GA-124		GA-92
	GA-110		
	GA-14		
	GA-92		
Jefferson River	BR-52	None	BR-52
	BR-101		BR-101
	GA-102		GA-102
	JV-203		JB-55
	JV-55		
	JV-95		
	JV-204		
	JV-202		
	JV-25		
Boulder River	JV-18	None	JV-18
	JV-80		JV-80
	JV-17		JV-17
	JV-81		JV-81
	JV-63		JV- 63
Upper Missouri Subbasin			
Deep Creek	BR-28	BR-28	BR-28
	BR-29		
Crow Creek	BR-35	BR-35	BR-35
Warm Springs Creek	BR-44	BR-44	BR-35
	BR-40	BR-40	BR-40
	BR-41	BR-41	BR-41
	BR-42	BR-42	BR-42
Smith River	CS-61	CS-61	CS-61
	GS-71	CSI-102	CS-71
	CSI-120	CS-251	CSE-102
	CS-251	CS-271	CS-251
	CS-252	CS-331	CS-252
	CS-271		CS-271
	CS-331		CS-331
	CSI-102		CSI-120

Subbasin/Streams	Consumptive Use Alternative	Instream Alternative	Combination Alternative
Sun River	TEI-80	CS-241	CSI-83
	CS-241	CSI-83	CSI-81
	CSI-83	CSI-81	CSI-82
	CSI-81	CSI-82	CSI-92
	CSI-82	CSI-92	CSI-91
	CSI-71	TE-571	TE-181
	TEI-100		
	CS-171		TE-183
	CS-471		LC-131
	CSI-92		TE-571
	TEI-90		
	CSI-91		
	CS-31		
	CS-51		
	CS-32		
	CSS-200		
	CS-231		
	TE-181		
	TE-183		
	CS-21		
	LC-131		
	TE-571		
	LC-251		
Belt Creek	CS-43	CS-43	CS-43
	CS-42	JB-281	CS-42
	CS-44		CS-44
	CS-159		CS-159
	CHS-1		JB-281
	JB-281		JB-61
	JB-61		
Marias/Teton Subbasin			
Cut Bank Creek	GL-221	GL-221	GL-221
	GL-11	GL-11	GL-11
Unnamed tributary of Bullhead Creek	PO-411	None	PO-411
	PO-271		PO-271
Timber Coulee	TO-421	None	TO-421
Laughlin Coulee	PO-91		
Spring Coulee	TE-361	None	None
Gamble Coulee	TE-581	TE-591	TE-591
	TE-591		
Unnamed tributary of Teton River	TE-401	None	None

Table 6-10 (continued)

Subbasin/Streams	Consumptive Use Alternative	Instream Alternative	Combination Alternative
Teton River main stem	CHI-61 TE-321 CHI-72 TEI-40 TEI-30 CHI-74 TEI-10 TEI-50 TE-411 TEI-60 CHI-80 TEI-20 TE-281 TE-282 TEI-70 CH-381 CH-641 TE-101 TE-81 TE-581 TE-591 TE-401 TE-361 CH-381	TE-321 CH-641 TE-101 TE-591	TE-321 CH-641 TE-101 TE-101
Middle Missouri Subbasin			
Unnamed tributary of Big Sag Creek	CH-551	CH-551	CH-551
Shonkin Creek	CH-201	CH-201	CH-201
Unnamed tributary of Campbell Coulee	FE-42	None	None
Wolverine Creek	FE-141	FE-141	FE-141
Running Wolf Creek	JBS-3	JB-261	JBS-3
Wolf Creek	FE-81	None	None
Little Casino Creek	FE-431	FE-431	FE-431
Olsen Creek	FE-671	FE-671	FE-671
Louse Creek	JB-21 JB-231 JB-232	JB-231 JB-232	JB-21 JB-231 JB-232
McCarthy Creek	JB-111	None	JB-111

arsenic averaging about 70 µg/L would be diverted for irrigation of Project GA-201 and would add arsenic to deep groundwater beneath the project. Because the groundwater drains into the Gallatin River, arsenic from the Madison drainage would be introduced into this stream. Measured background concentrations of arsenic in the Gallatin River have been less than 2 µg/L (USGS 1987).

Under the Consumptive Use and Combination alternatives, the already high arsenic concentrations in the Boulder River (6 to 38 µg/L) (USGS 1987) would increase. The Instream Alternative would help insure that the present dilution of arsenic in the Madison and Boulder rivers continues.

The Jefferson River would supply a substantial amount of water for irrigation projects in the Consumptive Use and Combination alternatives. During times of peak diversion when flows in the river are already low, the quality of remaining water would deteriorate as water temperatures rise and nutrients and salts from return flows enter the river. These impacts would be greatest under the Consumptive Use Alternative, less under the Combination Alternative, and least under the Instream Alternative.

Sufficient details are not available to thoroughly analyze the City of Bozeman's proposed reservation for a reservoir on Sourdough Creek. Depending on how the water storage project is operated, increased water use and reduced streamflow in Sourdough Creek might increase water temperatures and reduce dissolved oxygen levels. Short-term sedimentation would occur during reservoir construction.

Upper Missouri Drainage

In August of dry years, arsenic concentrations in the Missouri River at Toston already exceed the drinking water standard of 50 µg/L. Under the Consumptive Use Alternative, flow reductions could increase arsenic concentrations at Toston in August by about 27 percent in the driest year in 10 and about 16 percent during average years. In wet years, August arsenic concentrations could increase by approximately 6 percent. Table 6-11 shows the effect of flow reductions on arsenic concentrations. These calculations were based on limited data and assume that the amount (not concentration) of arsenic passing Toston does not change with flow.

New irrigation projects in the Sun River drainage would contribute to overall deterioration of water quality in the lower Sun River, with the greatest

Table 6-11. Predicted effect of the Consumptive Use Alternative on arsenic concentrations in the Missouri River during August at Toston, Montana

Percent of Time Flow or Arsenic Concentration is Equalled or Exceeded	Baseline Flow (cfs)	Arsenic Concentrations (µg/L)	Depleted Flow (cfs)	Arsenic Concentrations (µg/L)	Percent Increase
90	829	106	601	135	27
80	1,280	70	1,045	86	23
50	2,251	38	1,956	44	16
20	3,065	30	2,746	32	6
10	3,741	27	3,372	29	7

impacts occurring under the Consumptive Use Alternative. Return flows from projects in the Consumptive Use Alternative are expected to contain 525 mg/L TDS. TDS concentrations in the Sun River are already high, and return flows could raise TDS above the drinking water standard of 500 mg/L (see Figure 6-19).

Project TE-571—included in all alternatives—would reduce flows in Muddy Creek, and return flows from the project would contribute sediment to the stream. Muddy Creek is heavily polluted and has a high sediment load.

In the Consumptive Use Alternative, project CS-42 would flood-irrigate 124 acres along Belt Creek and streambank erosion would add sediment to the stream. Under the Consumptive Use and Combination alternatives, projects CS-44 and CS-42 on Belt Creek have high potential to contaminate a shallow (10-15 feet) aquifer with pesticides and nutrients from fertilizers.

Increased TDS concentration from irrigation projects in the main-stem Missouri River would be small under all alternatives.

Marias/Teton Subbasin

The Marias and Teton drainages support extensive irrigation, and new projects would increase water quality problems. Water in these rivers typically contains TDS concentrations of about 360 mg/L. Return flows from irrigation in this area contain about 720 mg/L of TDS. Assuming a worst-case situation, TDS concentrations in the Marias and Teton rivers would increase from 360 mg/L to 379 mg/L near Loma but would not exceed the public drinking water standard of 500 mg/L.

Project BSS-2 in the Consumptive Use Alternative would irrigate nearly 20,000 acres. Most return flows and potential pollution from this large project would flow northeast to the Milk River drainage via ancient river channels and aquifers. Because of the size of this project, effects on the Milk River and Big Sandy Creek could be substantial. Detailed environmental analysis would be required to assess these potential effects.

The Consumptive Use Alternative would reduce Teton River flows substantially, and more frequently to zero, so water temperatures could rise and dissolved oxygen could drop to the point where aquatic life might be harmed. The Combination and Instream alternatives include few projects and impacts would be less. Projects TE-361, TE-401, and TE-581 in the Consumptive Use Alternate and Projects CH-641 and TE-591 in all alternatives involve reservoir construction which would contribute sediment to the river.

Middle Missouri Subbasin

Under the Consumptive Use and Combination alternatives, BUREC would divert 280 cfs from the Missouri River near Virgelle to a canal system leading to the Milk River near Havre. Canal construction and seepage from the canal would contribute sediments and salts to Big Sandy Creek. Arsenic from the Missouri River would be introduced into the Milk River via this canal. Estimated arsenic concentrations in water diverted from the Missouri River are

between 10 and 17 µg/L (DHES 1989). This compares to arsenic levels in the Milk River ranging from less than 1 µg/L to 6 µg/L. DNRC estimates that during the 2 driest years out of 10 on the Milk River near Havre, average arsenic concentrations would increase about 50 percent from 4 µg/L to 6 µg/L in July and August as a result of the BUREC project. This increase is well below the public drinking water standard of 50 µg/L, but any increase in arsenic would violate the BHES surface water instream standard of 20 nanograms per liter. The arsenic would pose a health risk to communities and persons using Milk River water as a drinking supply. Furthermore, using water with elevated arsenic levels for irrigation could increase arsenic in groundwater. Cities along the Milk River would have to further treat their water to maintain existing drinking water quality (Table 6-12). Diverting Missouri River water into the Milk River also could change water temperatures, but the effects of this on aquatic life in the Milk River are uncertain.

In the Judith drainage, project FEI-50 included in the Consumptive Use Alternative could contribute nutrients to a shallow aquifer which would affect the water quality of springs along bench margins. The same potential exists for projects FEI-671, FEI-672, FE-673, and FEI-40 in both the Consumptive Use and Combination alternatives. JBS-3 in all alternatives would divert water from Running Wolf Creek. It is questionable whether the existing water quality (high TDS concentrations) in Running Wolf Creek is suitable for irrigation (Judith Basin Conservation District 1989) and the project could increase TDS further. Project FE-141, included in all alternatives, would contribute sediment to the river during construction of two water storage projects.

Table 6-12. Municipalities using Milk River water or adjacent groundwater that would contain elevated arsenic levels as a result of BUREC Virgelle diversion

Municipality[b]	Source[a]	Population Served[c]
Havre	SW/GW	10,580
Chinook	SW	1,600
Harlem	SW	960
Malta	GW	2,480
Glasgow	SW/GWd	4,455

a GW = groundwater in hydrologic contact with the Milk River, SW = Milk River water
b Other well source users outside of cities could also be affected
c U.S. Bureau of Census - 1980 and 1988
d Glasgow diverts public drinking water from Fort Peck Reservoir and also maintains wells near the city for standby use only.

In the Musselshell River drainage, the quality of water in the Jeffrey Mine, which would be pumped as part of Project LM-20, probably would not change in response to pumping for the project. If the mine water is used only when river flows are low, the Jeffrey Mine water would decrease major constituents and TDS in the Musselshell River. The water in other area mines—the Republic #2, Prescott, and Roundup #3—is not suitable for irrigation because of high TDS, sulfates, and sodium. If these mines were to be used to store water, the water in them would have to be purged periodically when flows in the Musselshell River are high. This would require a discharge permit from DHES and possible treatment of the mine water if dilution flows in the river are not sufficient. The quality of groundwater seeping back into the mines may be comparable or superior to that of the river at low flows. If inflow is sufficient, it might be possible to use this water periodically for irrigation.

The mine water also would contain dissolved iron which probably would precipitate as ferric hydroxide when discharged into surface water. Aeration and settling at a minimum would be required to avoid iron oxide deposition which would form an orange coating in the stream channel. Manganese also is present in the water at concentrations that might require treatment to avoid deposition in the stream channel.

Pentachlorophenol, a carcinogen, has been detected at low concentrations at one site in the Roundup #3 Mine. The source of this contamination is uncertain, but it may be locally generated near the sampling point. Discharge of detectable pentachlorophenol probably would be precluded by DHES nondegradation rules.

Project VAS-1, included in all alternatives, would divert water from Fort Peck Reservoir and increase concentrations of nutrients and salts in the Milk River and Missouri River below Fort Peck Dam. Surface runoff and excess canal flow from the project also would contribute sediment to the rivers. Arsenic in return flows from the diversion waters could contaminate a short segment of the Milk River. Present

arsenic levels in the Milk River near Nashua are 2 to 6 µg/L. The introduction of Missouri River water containing 10 to 17 µg/L would violate the BHES surface water (instream) standard of 20 nanograms per liter. Because the town of Nashua obtains its drinking water from two wells that are thought to have their source in the Porcupine Valley aquifer, this supply would not be affected.

SOILS AND STREAM CHANNEL FORM

SOILS - GENERAL IMPACTS AND CONSIDERATIONS

The degree to which soils are affected by irrigation depends upon existing land use, soil type, and irrigation management practices. Applying supplemental water to currently irrigated land has less effect on soils than converting native rangeland to irrigated agriculture. Irrigation in a semi-arid region can have a profound effect on long-term soil productivity through its effects on soil salinity.

The concentration of salts in soil increases as water is removed by evaporation or used by plants. This increase can be controlled by leaching, which is the practice of applying more irrigation water than crops require. Leaching prevents excessive salinity in the root zone by moving salts downward through the soil faster than they are added by irrigation water and other sources. Without leaching, soil salt levels in a semi-arid climate will increase and productivity will decrease.

Several changes to soils occur when dryland farming is replaced by irrigation. Wind erosion rates decrease during the irrigation season on cultivated fields because wet soils are more resistant to erosion. Irrigation enhances crop cover during the growing season and provides more protection from wind and water erosion than dryland crops. Irrigation also increases plant residues returned to the soil. Soil structure is improved, microbe populations benefit from the added food source, and nitrogen fertility is enhanced. Tables 6-16 through 6-19 list acreages by subbasin where dry cropland would be converted to irrigated agriculture and the above mentioned effects to soils would occur.

The effects of converting rangeland to irrigation are quite different from those associated with converting cropland. Researchers have measured decreases in organic carbon of 25 to 60 percent as a result of cultivating native rangeland, with total nitrogen decreases of 24 to 50 percent (Blank and Fosberg 1989; Baur and Black 1981; Campbell and Souster 1982; Dormaar 1979). Organic matter losses of 15 percent were measured by Lehane and Staple (1943) within the first 10 months after cultivation. Annual losses would be greatest during the first 20 years and would stabilize after the first 50 years (Doughty et al. 1954). These changes are likely to reduce the ability of soils to hold water, increase soil susceptibility to erosion, and increase the need for chemical fertilizers (Blank and Fosberg 1989; Campbell and Souster 1982).

These effects would be reduced somewhat by alfalfa production. Alfalfa, as a nitrogen-fixing plant, increases the amount of nitrogen available to subsequent crops. The addition of alfalfa residues would lessen the loss of organic carbon. The perennial cover of an alfalfa crop would reduce erosion throughout the year and provide additional moisture by trapping snow. An alfalfa-grain rotation would disrupt weed and insect pest cycles established under dryland cropping patterns. Tables 6-16 through 6-19 list acreages where rangeland would be converted to irrigated agriculture and where associated effects would occur.

Unless otherwise noted, supplemental irrigation of existing irrigated land would not have substantial effects on soils.

Municipal requests generally would have minor adverse effects on soils. Soil erosion and compaction would occur at well sites, storage tank construction sites, and along pipeline routes. Short-term losses in soil productivity would occur until revegetation stabilizes disturbed areas.

SOIL IMPACTS DUE TO PIPELINE CONSTRUCTION

Pipeline construction can reduce agricultural production by compacting soil and mixing soil layers. Mixing topsoil with subsoil reduces organic matter and nutrients available to plants, increases stoniness, and leaves higher concentrations of salts near the surface (Mutrie and Wishart 1987). Compaction crushes the structure of topsoil and reduces porosity, creating an impenetrable layer of "hardpan."

These adverse effects can be minimized with proper procedures. To eliminate mixing, soil could be double-lifted during trenching. With this technique,

the topsoil is excavated, stored, and replaced separate from the subsoil. During construction, either the entire right-of-way could be cleared or just one side, including the trench and the soil storage area. If the working side is not cleared, deep ripping may still be necessary to correct compaction caused by heavy vehicle traffic. Retaining stubble and plants will also help prevent compaction.

Although not specifically stated in the applications, it is assumed that the pipelines for irrigation projects will be buried at least 3 feet deep to clear tillage equipment and to protect them from vandalism. Table 6-13 shows miles of pipeline greater than 17 inches in diameter as included in the 14 largest irrigation projects. Pipes this large constitute anywhere from 6 to 100 percent of the total pipeline length in each of these projects. The project requiring the most pipeline (VAS-1) would have 27.7 miles of large-diameter pipe (greater than 17 inches), which is 31 percent of the total 90.5 miles of pipe needed for the project. The other 62.8 miles would be 8 to 17

Table 6-13. Soil disturbance due to pipeline construction

Subbasin/Drainage	Alternative					
	Consumptive Use		Instream		Combination	
Project	Miles	Acres	Miles	Acres	Miles	Acres
Headwaters						
Madison						
GA-201	18.5	223.6	0	0	18.5	223.6
Jefferson						
JV-201	0.2	2.8	0	0	0	0
JV-202	1.6	19.5	0	0	0	0
BR-101	1.5	18.4	0	0	1.5	18.4
Upper Missouri						
Missouri above Holter						
BR-104	1.2	14.7	0	0	0	0
Sun						
CSS-200	4.9	59.2	0	0	0	0
Marias/Teton						
Marias						
BSS-2	26.7	323.2	0	0	0	0
Middle Missouri						
Missouri above Fort Peck						
CHS-6	14.6	176.8	0	0	0	0
CHS-5	0.7	8.7	0	0	0.7	8.7
CHS-3	4.4	53.7	0	0	4.4	53.7
BUREC	ND[a]	ND[a]	0	0	ND[a]	ND[a]
Judith						
FEI-50	3.4	41.5	0	0	0	0
Musselshell						
LM-20	1.5	17.6	0	0	0	0
Fort Peck						
VAS-1	27.7	336.3	27.7	336.3	27.7	336.3
TOTAL	106.9	1,296.0	27.7	336.3	52.8	640.7

a Application contains no data regarding pipeline length. Disturbance for pipeline construction assumes a standard 100-foot right-of-way. Data compiled for 14 largest irrigation projects.

inches in diameter. Soil disturbance for these smaller pipes is not shown in the table. The acre figures in Table 6-13 assume a standard 100-foot right-of-way width during construction.

Erosion on streambanks and steep slopes also would occur from pipeline construction, though soil erosion can be reduced with proper drainage, timely construction, and reclamation. These techniques are commonly used in pipeline construction. Proper drainage can be ensured by installing cross-ditch and berm structures and subdrains. Construction should occur during periods of low stream flow and when soil is dry to avoid rutting and compaction. Recontouring streambanks and slopes to their original configuration and planting native plants or cover crop species will decrease erosion. In highly erodible soils, mulch can be used to protect the soil until vegetation emerges.

Soil productivity would be lost on land converted to canals necessary for these irrigation projects. Canal lengths for the 14 largest projects are shown in Table 6-14.

Table 6-14. Soil disturbance due to canal construction

Subbasin/Drainage Project	Alternative: Consumptive Use (miles)	Instream (miles)	Combination (miles)
Headwaters			
Madison			
GA-201	18	0	18.0
Jefferson			
JV-201	8.6	0	0
JV-202	7.2	0	0
BR-101	9.5	0	9.5
Upper Missouri			
Missouri above Holter			
BR-104	18.0	0	0
Sun			
CSS-200	7.0	0	0
Marias Teton			
Marias			
BSS-7	16.9	0	16.9
Middle Missouri			
Missouri above Fort Peck			
CHS-6	15.0		
CHS-5	5.0		5.0
CHS-3	7.0		7.0
BUREC	46.0	0	46.0
Judith			
FEI-50	6.0	0	0
Fort Peck			
VAS-1	32.0	32.0	32.0
TOTAL	796.2	32.0	134.4

Impacts of the Consumptive Use, Instream, and Combination Alternatives

Gallatin River Drainage

Supplemental irrigation of 2,164 acres in the Consumptive Use Alternative and 1,424 acres in the Combination Alternative in the Gallatin River drainage would increase the net downward movement of soluble salts in well drained soils. However, poor drainage caused by a high water table would not allow adequate leaching in projects GA-140, GA-124, and GA-130 in the Consumptive Use Alternative, and GA-143 in both the Consumptive Use and Combination alternatives. As a result, the soluble salt concentrations of the soils would increase over time, and productivity would be damaged unless artificial drainage systems such as subsurface tile or drainage ditches are installed.

Bozeman's requested water reservation requires a dam that would inundate up to 118 acres on Sourdough Creek. Productivity of soil under or adjacent to the reservoir would be irretrievably lost because of inundation and erosion along the reservoir shoreline. Soil also would be damaged by surface disturbance and compaction in the dam construction area. Construction to widen the existing road and replace the portion flooded by the reservoir would cause additional soil productivity losses. Further soil erosion and compaction would result if recreational facilities are constructed to improve public access to the reservoir. Impacts would be less under the Combination Alternative because the reservoir would be smaller.

Madison River Drainage

Project GA-201 is included in both the Consumptive Use and Combination alternatives. Seventy-five percent of the project acreage would be converted from dryland cropping to sprinkler irrigation, reducing wind erosion on silt loam and sandy loam soils that are susceptible to blowing.

Project GA-201 would use Madison River water with high concentrations of arsenic. Arsenic occurs

naturally in most soils, and the measured range of arsenic in Montana soils is 2-12 ppm (Williams 1940). The movement of arsenic through the soil with percolating water is limited by its strong tendency to bind with iron and aluminum oxides, clay particles, organic matter, and calcium (Alina and Henryk 1984). Soils receiving large applications of arsenic pesticides show little evidence of arsenic movement below the tillage depth (Williams 1940). Arsenic concentrations in Madison River water upstream from the proposed diversion point range from 41 to 95 ppm (Sonderegger et al. 1989). Assuming an average concentration of 65 ppm in the irrigation water and an annual irrigation application of 1.5 acre-feet per acre, the annual addition of arsenic to the surface 6 inches of soil would be 0.13 ppm. At this rate of accumulation, the median natural concentration of 7.0 ppm reported by Williams (1940) for Montana soils would be doubled to 14 ppm after 53 years of irrigation. To reach the plant toxicity level of 70 ppm reported by Alina and Henryk (1984) would take 470 years. This result assumes no losses of arsenic through deep percolation, surface erosion, or plant uptake and harvest.

An investigation by Sonderegger et al. (1989) showed that groundwater in the lower Madison valley is contaminated with arsenic concentrations as high as 130 μg/L from irrigation with Madison River water. This finding shows that some arsenic in irrigation water would remain in the water and be carried off in return flows rather than accumulating in soil.

The removal of arsenic from the soil as described above would further slow the accumulation of soil arsenic to toxic levels. Therefore, no short-term adverse effects to soil related to arsenic would result from irrigation with Madison River water. Several hundred years would be required to accumulate toxic arsenic levels in soil.

Jefferson and Boulder River Drainages

The cultivation of annual crops on converted rangeland within projects JV-201 and JV-203, included in the Consumptive Use Alternative, would expose approximately 3,400 acres of sandy loam-textured soils to accelerated wind erosion. Maximum annual losses from these soils in fallow condition would range between 80 and 140 tons per acre. Crop cover and surface wetness from irrigation would control losses to some degree. Projects JV-201, JV-202, and BR-101 included in the Consumptive Use Alternative would include new flood irrigation on 3,725 acres and sprinkler irrigation on 8,690 acres. Water erosion losses are more difficult to control with flood irrigation than with sprinklers. The potential erosional losses are difficult to quantify because the boundaries of sprinkler and flood irrigation areas have not been identified.

Salinity problems would be aggravated under the Combination and Consumptive Use alternatives. Project GA-102, included in both alternatives, is underlain by soil that is somewhat poorly drained and slightly saline. Without artificial drainage, irrigation would lengthen the duration of the seasonal high water table and increase the soluble salt content of the soil. One of the seven parcels comprising project JV-95, included only in the Consumptive Use Alternative, is underlain by a saline soil. Irrigation of this parcel would result in further waterlogging and salt accumulation. In the Consumptive Use Alternative, the area of shallow water table and associated saline soils adjacent to the Jefferson River floodplain within project JV-203 would expand because leaching from irrigation would increase groundwater in shallow water tables. Soil salinity would increase unless artificial drainage is installed. Three of the five parcels comprising project JV-204, included only in the Consumptive Use Alternative, are poorly drained and have saline soils. Saline and waterlogged conditions would worsen with irrigation unless the parcels are artificially drained.

With conversion of pasture/rangeland to irrigated cropland, the annual wind erosion rates could be 80-90 tons per acre on the sandy loam soils of project JV-63 until crop cover is established.

Big Hole, Beaverhead, Ruby, and Red Rock River Drainages

No adverse effects on soils would result from reservations in these drainages.

Missouri River Drainage - Three Forks to Holter Dam

Approximately 500 acres of rangeland in project BR-103 would be flood- irrigated under the three alternatives. Over 50 percent of the project is underlain by soil that holds less than 3 inches of water available to plants and has rapid permeability (6-20 inches per hour). The frequent flooding that would be required on this area would degrade soil quality by removing silt and sand-sized particles and increasing the proportion of surface gravel and cobbles.

Excessive movement of water through the soil would be difficult to control.

A report by Pardee (1925) described expanding areas of shallow groundwater with the onset of irrigation in the Townsend valley. Lorenz and McMurtrey (1956) reported that groundwater recharge from irrigation on coarse-textured alluvial benches in the Townsend valley caused elevated water tables and extensive soil waterlogging. Soil waterlogging may occur along the lower portion of project BR-103 under all three alternatives if water percolation below the root zone is not carefully controlled.

Problems with salinity and excessive sodium occur within projects BR-34 and BR-104 which are included only in the Consumptive Use Alternative. Irrigation of slowly permeable sodic soils covering 60 percent of BR-34 would increase surface evaporation and salt accumulation. Sodic soils would restrict water infiltration and drainage. Similar problems would occur on 700 acres in project BR-104, where the soil is poorly drained and would not allow leaching.

Missouri River Drainage - Holter Dam to Belt Creek Drainage

Environmental effects in this drainage would be typical of those associated with converting rangeland and dry cropland to irrigated agriculture as discussed in the general impacts and concerns section.

Dearborn River Drainage

A single irrigation project in this drainage would convert 173 acres of rangeland to irrigated land under the Consumptive Use and Combination alternatives. Surface runoff and erosion would accelerate on a portion of the project that has 8-15 percent slopes. Surface salts have accumulated around the perimeter of a small depression north of the project. The saline area would expand if runoff or percolating irrigation water from the project discharges to the area and evaporates. The project is not included in the Instream Alternative so these stated effects would not occur in this alternative.

Smith River Drainage

Project MEI-11, included only in the Consumptive Use Alternative, contains areas of slightly saline subsoils. Adequate leaching would be required to prevent further salt accumulation. Projects CSI-111 and CSI-120, as included in the Consumptive Use and Combination alternatives, are in dry cropland and have sandy loam soils that are susceptible to wind erosion. These soils would gain notable benefits when they are converted to irrigated alfalfa. On the other hand, the sandy loam soil within project CS-251, included in all three alternatives, would be seriously affected by wind erosion until crop cover is established on rangeland converted to irrigation.

Sun River Drainage

Approximately 6,300 acres would be converted from dryland farming to irrigation in the Sun River drainage under the Consumptive Use Alternative. Eighty percent of this acreage is within project CSS-200. Small areas of saline soils and saline seep are included the project. Alfalfa production could reduce saline seeps by preventing deep percolation of water. Saline seep areas would expand if irrigation is not controlled to prevent excess percolation below the root zone.

Increased erosion would occur after native sod is removed from 8-10 percent slopes along the northern edge of project CS-471, included in the Consumptive Use Alternative.

Belt Creek Drainage

Project CHS-1, included in the Consumptive Use Alternative, contains 1,343 acres. Soils on the project are fine-textured clay loams and silty clay loams that can restrict drainage. Poor subsoil drainage would lead to soil waterlogging and salt accumulation within a few years. Deep drainage characteristics within project CHS-1 should be further investigated prior to development. Artificial drainage may be required to prevent soil waterlogging.

Marias River Drainage

Over 90 percent of the acreage that would be irrigated under the Consumptive Use Alternative in this drainage is within project BSS-2. The soils in BSS-2 are predominantly sandy loams overlying clay-textured glacial till. Small areas of saline soil occur within the project, indicating restricted drainage. BUREC (1949) anticipated the possibility of restricted drainage in the area and recommended that any irrigation development should be accompanied by artificial drainage. The saline soil areas will expand with irrigation if restricted drainage causes a rising water table. Increased plant cover would be important for conserving the sandy soils that are susceptible to wind erosion on project BSS-2.

Minor saline seep areas occur adjacent to projects GL-11 and GL-221, included in all three alternatives, and near PO-411 included in both the Consumptive Use and Combination alternatives. Irrigation water would have to be applied within the limits of soil moisture storage capacity to meet leaching requirements and to prevent expansion of the seeps.

A storage reservoir is proposed for project PO-91, which is included in the Consumptive Use Alternative. Soil productivity would be permanently lost on 35 acres flooded by the reservoir.

The Marias River bank is stabilized by woody vegetation along most of the perimeter of project TO-221, which is included in all three alternatives. Removal of this vegetation would allow streambank erosion to gradually reduce the size of the field.

Nine of the projects in the Consumptive Use Alternative, seven in the Combination, and two in the Instream are designed with pipelines crossing steep terrain between the Marias River floodplain and upland benches. The slope gradients along these pipelines range from 25 to 45 percent. Surface runoff and erosion would increase in these areas as a result of vegetation removal and compaction caused by construction equipment.

Municipal requests have been submitted by the cities of Chester, Conrad, Cut Bank, and Shelby in the Marias River drainage. Minor adverse effects of soil compaction and erosion would result from well development and pipeline construction proposed by Chester, Conrad, and Shelby. Soil productivity would be permanently lost on approximately 108 acres inundated by the reservoir proposed under the Cut Bank off-stream storage proposal. The proposed 3,800-foot pipeline from Cut Bank Creek to the reservoir would cross slopes with gradients from 15 to 60 percent. Soil compaction and accelerated erosion would occur until the area is stabilized by reclamation.

Teton River Drainage

Five storage projects are proposed in the Teton River drainage. Soil productivity would be permanently lost with the combined flooding of approximately 240 acres by reservoirs within project CH-641, included in all three alternatives, and projects TE-361, TE-401, and TE-581, which are included only in the Consumptive Use Alternative. The largest reservoir, project TE-591, is included in all three alternatives and would flood 150 acres.

Missouri River Drainage - Belt Creek to Fort Peck Reservoir

The soils within three large projects—CHS-3, CHS-5, and CHS-6—are predominantly clays, clay loams, and silty clay loams. Sand-textured soils underlain by fine-textured till also are extensive. Although the soils are described as well drained, poor subsoil drainage through till with poor permeability may lead to soil waterlogging and salt accumulation within a few years. Deep drainage characteristics within these projects should be investigated before development. All three of these projects are in the Consumptive Use Alternative, and CH-3 and CH-5 also are in the Combination Alternative.

Approximately 1 mile of road construction would be required for development of project FEI-20, which is included only in the Consumptive Use Alternative. Construction would occur on steep terrain with shallow soils and bedrock outcrops of sandstone and shale. Soil productivity would be lost within the road right-of-way and erosion would accelerate during and after construction.

Judith River Drainage

Storage reservoirs are proposed for projects FE-2, FE-81, FE-141, and FE-161, which are included in the Consumptive Use Alternative. Soil productivity would be permanently lost on approximately 100 acres inundated by the four reservoirs. Less soil would be lost under the Instream Alternative, which contains only one project, FE-141 (20 acres), and the Combination Alternative, which contains two storage projects, FE-141 and FE-161 (32 acres). Approximately 5,400 feet of canal are proposed for project FE-161. Soil compaction and erosion would occur under the Consumptive Use and Combination alternatives during canal construction.

Fort Peck Reservoir

The soils within project VAS-1, a 25,020-acre project included in all three alternatives, are predominantly loams and clay loams developed from fine-textured glacial till or alluvium. The soils are described as well drained, but deep drainage through sediments with poor permeability may be restricted and lead to soil waterlogging and salt accumulation with irrigation. Deep drainage characteristics should be investigated prior to development.

Milk River Drainage

Under the Consumptive Use and Combination alternatives, BUREC would provide supplemental

water to 47,000 acres of presently irrigated land, and 6,600 acres of cropland would be developed for new irrigation. Site-specific effects on soils in this drainage are unknown because specific land locations are not included in BUREC's application. Construction of the diversion canal for the project would disturb soils, and seepage from the canal could create saline seeps. These impacts would need to be adequately assessed before project construction begins.

Stream Channel Form

BLM has requested minimum flows for habitat protection and bankfull flows for channel maintenance on 31 streams in the Headwaters Subbasin. Also, DFWP has requested higher spring flows along with minimum flows on Wegner, Stickney, Big Dry and Little Dry creeks, and the middle portions of the Missouri River. Under all three alternatives, protecting these flows would help maintain the existing channel characteristics of these streams.

For most basin streams, the proposed consumptive use reservations would cause little or no reduction to spring runoff flows which are important in maintaining channel form. An exception would be the Bozeman request to construct a reservoir on Sourdough Creek. This project, which is included in all alternatives, would store high spring flows, thereby reducing peak flows below the dam. Sediment also could be deposited in the stream channel below the dam during construction, especially if proper erosion control measures are not taken. Deposition of sediments during construction in conjunction with reduced spring flows could lead to a narrowing of the stream channel as riparian vegetation becomes established within it.

Also, reduced summer flows under the Consumptive Use and Combination alternatives would leave portions of some stream channels dry. This would be especially true on the Jefferson River and on other streams as discussed in the water quantity and distribution section. In such instances, vegetation may become established during the summer in the dry portions of these channels. These plants would trap sediments when flows are higher which could lead to an eventual reduction in stream channel size. When a stream channel becomes smaller, its ability to convey water is reduced and the frequency of flooding can increase. These impacts would be greatest under the Consumptive Use Alternative and least under the Instream Alternative.

LAND USE

General Impacts and Considerations

Land use would change when nonirrigated cropland, pastures, or rangelands are converted to irrigated cropland. Some projects would require land to be cleared and leveled. Most projects would require construction of a water distribution system, including canals, pipelines or both.

Construction of pipelines, canals, and electric lines for irrigation projects also may alter land uses on land that would not benefit from new irrigation. This activity could cause short-term impacts from noise, traffic, and dust. Tables 6-13 and 6-14 indicate the length of pipelines and canals on projects greater than 2,500 acres.

Most electric lines proposed for irrigation projects would have low impacts if located on a single owner's property and sited within an existing road corridor, utility corridor, or fence line. Impacts also would be low if lines were located to avoid cultivated land, easily reached from existing roads, and built so construction disturbance was low and away from residences, commercial areas, and recreation sites.

Impacts could be higher where electric lines are 5 miles or longer, and for large capacity lines (requiring upgrading/reconstruction of local supply lines). Longer lines could cross land where they would conflict with existing or future land uses such as parks, recreation areas, tribal lands, residential/commercial areas, mechanically irrigated fields, orchards, mines, or areas managed to protect water, wildlife, or visual resources.

Additional information on the location of proposed electric lines for irrigation projects would be required to fully assess land use impacts. Table 6-15 lists projects with associated electric lines 5 or more miles long that have potential to cause land use impacts. These impacts might be reduced or avoided altogether through proper line siting.

Most of the proposed development projects are smaller than 500 acres and would have little effect on local transportation, with only short-term increases in traffic during time of construction. On large projects, construction of pipelines or canals may cause short-term transportation delays. In some locations, low standard roads may have to be rerouted or abandoned. Projects of 2,500 or more

Table 6-15. Projects requiring electric lines 5 or more miles in length

Project	Electric line length (miles) Consumptive Use Alternative	Instream Alternative	Combination Alternative
Headwaters Subbasin			
GA-201	80.0	—	80.0
JV-95	5.0	—	—
Headwaters Subtotal	85.0	0.0	80.0
Upper Missouri Subbasin			
KBR-104	8.1	—	—
CS-21	10.0	—	—
CSS-200	10.0	—	—
CHS-1	10.0	—	—
LCI-20	5.8	—	5.8
TEI-80	5.0	—	—
TEI-90	5.0	—	—
TEI-100	5.0	—	—
Upper Missouri Subtotal	58.1	0.0	5.0
Marias/Teton Subbasin			
BSS-2	16.9	—	—
CH-381	5.0	—	—
CH-641	5.0	5.0	5.0
CHI-51	5.0	5.0	5.0
CHI-52	5.0	—	5.0
CHI-53	5.0	5.0	5.0
CHI-61	5.0	—	—
CHI-72	5.0	—	—
CHI-74	5.0	—	—
CHI-80	5.0	—	—
HI-269	5.0	—	5.0
POI-10	10.0	—	10.0
TEI-10	5.0	—	—
TEI-20	5.0	—	—
TEI-30	5.0	—	—
TEI-60	5.0	—	—
TEI-70	5.0	—	—
Marias-Teton Subtotal	101.9	15.0	40.0
Middle Missouri Subbasin			
BUREC	11.0	—	11.0
CH-201	10.0	10.0	10.0
CH-211	10.0	—	10.0
CH-541	5.0	—	5.0
CHI-40	5.0	5.0	5.0
CHS-3	40.0	—	40.0
CHS-5	40.0	—	40.0
CHS-6	40.0	—	—
FE-81	5.0	—	—
FEI-20	10.0	—	—
FEI-50	10.0	—	—
JBI-2	5.0	—	—
VAS-1	10.0	10.0	10.0
Middle Missouri Subtotal	201.0	25.0	131.0
TOTAL MILES	446.0	40.0	256.0

acres would cause a small increase in the existing level of traffic on local and county roads during transport of hay or other agricultural products over the long term.

The conservation districts have indicated that alfalfa is the crop most likely to be irrigated with reserved water. This is because alfalfa is considered a highly profitable crop for repaying irrigation investments. Alfalfa yields from irrigated land (described in Chapter Four - Land Use) are expected to continue increasing, going from the present average 3.0 tons per acre to 3.9 tons per acre by the year 2020 (Figure 6-21), resulting in a 31 percent increase in alfalfa production paer acre. Virtually all alfalfa is used for livestock feed. Montana cattle numbers are projected to remain stable (or decline slightly), while beef production efficiency is expected to increase (USDA 1989), reducing the demand for alfalfa. Existing alfalfa acreage with high production costs may go out of production if less expensive production occurs elsewhere as a result of water reservations.

Municipal water reservations generally would require development of a water source (well or water intake structure) and a pipeline to the municipal water treatment facility. In most cases, these developments involve short-term construction activities, with the bulk of the affected land returning to former uses. The exception would be the City of Bozeman's proposed reservoir on Sourdough Creek south of Bozeman. This project would change land uses in the Gallatin National Forest and on other private and municipal land, inundating up to 118 acres. Development of municipal reservations also could involve modifications or construction of electric lines just south of Bozeman.

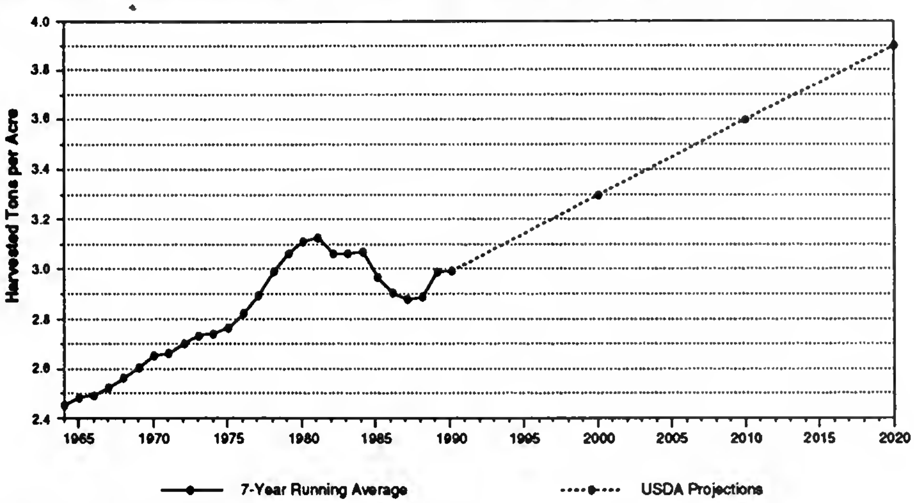
Instream flows generally have little direct effect on land use. On some streams, instream reservations may constrain future irrigation development.

Impacts of the Consumptive Use, Instream, and Combination Alternatives

Headwaters Subbasin

Under the Consumptive Use Alternative, approximately 26,200 acres of land would be irrigated with reserved water, increasing irrigated acreage in the subbasin by 7 percent. These projects would increase total irrigated alfalfa acreage by about 16,000

Figure 6-21. Irrigated alfalfa yield trends and projections in Missouri River basin counties



Sources: Montana Crop and Livestock Reporting Service 1964 through 1989
USDA 1989

acres, or 10 percent, by the year 2020. Most of this land presently is unirrigated cropland, pasture, or rangeland (Table 6-16). Of these 26,200 acres, 13 percent are already irrigated when water is available.

In the Combination Alternative, approximately 13,100 acres would be irrigated with reserved water, increasing subbasin irrigated acreage 4 percent. About 4,500 acres of this land probably would be planted to alfalfa, which would increase irrigated alfalfa acreage in the subbasin by 3 percent in the year 2020. The remainder would be in potatoes and small grains. Over half of the land included in the Combination Alternative is currently in cultivation, and about one-quarter is irrigated when water is available.

Under the Instream Alternative, no additional land would be irrigated with reserved water in this subbasin.

GALLATIN RIVER DRAINAGE

Most irrigation projects included under the Consumptive Use and Combination alternatives in the Gallatin drainage would be smaller than 500 acres, and would supplement existing irrigation with water from on-site wells. Because of this, overall land use impacts would be very small. Some project land has already been converted to residential uses or may be planned for such use. The following sites have residential developments located on at least part of the project which would preclude development of the projects as proposed: GA-40, GA-41, GA-44, GA-46,

Table 6-16. Present land uses on areas where reservations for irrigation are proposed in the Headwaters Subbasin

	Alternative		
Drainage	Consumptive Use	Instream	Combination
Gallatin			
cropped (acres)	2,164	0	1,424
pasture/range (acres)	354	0	330
total acreage	2,518	0	1,754
total number of projects	16	0	11
Madison			
cropped (acres)	5,900	0	5,900
pasture/range (acres)	1,990	0	1,990
total acreage	7,890	0	7,890
total number of projects	1	0	1
Jefferson/Boulder			
cropped (acres)	5,320	0	1,740
pasture/range (acres)	10,445	0	1,775
total acreage	15,765	0	3,515
total number of projects	15	0	4
Big Hole, Ruby, Beaverhead and Red Rock			
cropped (acres)	0	0	0
pasture/range (acres)	0	0	0
total acreage	0	0	0
total number of projects	0	0	0
Headwaters Subbasin Totals			
cropped (acres)	13,384	0	9,064
pasture/range (acres)	12,789	0	4,095
total acreage	26,173	0	13,159
total number of projects	32	0	16

GA-79, GA-110, GA-124, GA-130, and GA-151 under the Consumptive Use Alternative, and sites GA-44, GA-46, GA-79, and GA-151 under the Combination Alternative. These irrigation projects are near Bozeman and in an area where substantial residential growth is expected. It is likely that a number of proposed irrigation sites will be converted to residential subdivisions before the projects are developed.

Madison River Drainage

The Consumptive Use and Combination alternatives would have the same impacts in this drainage. Sixty-four large center pivot sprinklers on project GA-201 would be used to irrigate 7,890 acres of potatoes and mixed grains. If, as proposed, one-sixth of this acreage were planted to potatoes each year, the current potato acreage in the subbasin would increase 28 percent from 3,400 acres to 4,700 acres (MT Agric. Stats. 1989). The addition of 1,300 acres of potatoes would increase Montana's current potato acreage of 7,800 by 17 percent. The project would require construction of large facilities—pumping stations, pipelines up to 60 inches in diameter, and electric lines—off the project owners' land. The proposed pipeline would cross existing irrigation ditches and roads.

Jefferson and Boulder River Drainages

Under the Consumptive Use Alternative, nearly all new acreage would be in four large irrigation projects: BR-101, JV-201, JV-202, and JV-203. JV-202 encompasses several rural residence developments that could preclude some irrigation and possibly conflict with construction of the proposed irrigation canal. Project JV-203 includes a highway, a railroad, and steep topography that would make project construction and operation difficult.

In the Boulder River drainage, 480 acres of mixed cultivated and pasture land would be irrigated under the Consumptive Use Alternative, but not under the Instream or Combination alternatives.

Upper Missouri Subbasin

Impacts would be greatest under the Consumptive Use Alternative where about 26,300 acres would be irrigated with reserved water, increasing irrigated acreage in the Upper Missouri Subbasin by 19 percent. Slightly less than two-thirds of this land (62 percent) is presently in cropland (Table 6-17). At present, 800 acres are irrigated and 1,000 acres are subirrigated. Alfalfa acreage would increase by about 23,000 acres, or 38 percent, by the year 2020.

Table 6-17. Present land uses on areas where reservations for irrigation are proposed in the Upper Missouri Subbasin

	ALTERNATIVE		
Drainage	Consumptive Use	Instream	Combination
Missouri-Three Forks to Holter			
cropped (acres)	5,600	2,475	2,410
pasture/range (acres)	6,339	1,389	1,414
total acreage	11,939	3,864	3,824
total number of projects	23	19	18
Missouri-Holter Dam to Belt Creek			
cropped (acres)	1,642	1,413	1,642
pasture/range (acres)	734	590	704
total acreage	2,376	2,003	2,346
total number of projects	22	16	21
Dearborn			
cropped (acres)	0	0	0
pasture/range (acres)	173	0	173
total acreage	173	0	173
total number of projects	1	0	1
Smith			
cropped (acres)	1,382	551	694
pasture/range (acres)	690	152	253
total acreage	2,072	703	947
total number of projects	15	6	12
Sun			
cropped (acres)	6,436	831	1,225
pasture/range (acres)	1,325	76	584
total acreage	7,761	907	1,809
total number of projects	24	5	8
Belt			
cropped (acres)	1,366	125	303
pasture/range (acres)	603	140	323
total acreage	1,969	265	626
total number of projects	7	2	6
Upper Missouri Subbasin totals			
cropped (acres)	16,426	5,395	6,274
pasture/range (acres)	9,864	2,347	3,451
total acreage	26,290	7,742	9,725
total number of projects	92	48	66

Under the Combination Alternative, about 9,700 acres would be irrigated, increasing subbasin irrigation 7 percent. This alternative would allow irrigation of 8,300 acres of alfalfa, increasing alfalfa acreage 14 percent by the year 2020. Almost two-thirds (64 percent) of this land is currently cropland (Table 6-17), and a small portion (18 percent) is irrigated or subirrigated.

Under the Instream Alternative, reservations in this subbasin would have slightly less impact on

land use than the other two alternatives. About 7,700 acres would receive water for irrigation, increasing subbasin irrigated acreage by 6 percent. Two-thirds of this land currently is cropland (Table 6-17), and small portions are irrigated (785 acres) or subirrigated (718 acres). Upper Missouri Subbasin irrigated alfalfa acreage would increase 11 percent by the year 2020.

Under the Consumptive Use Alternative, the two largest projects—BR-104 (6,095 acres) and BR-103 (1,700 acres)—would irrigate land on the east side of Canyon Ferry Reservoir. This land has substantial subdivision development and road networks that would hinder project development.

Under all three alternatives, BR-108, also on east shore of Canyon Ferry Reservoir, would require relocation of the electric distribution line to a nearby marina complex. CSI-102 overlaps a state recreation site near the confluence of the Smith and Missouri rivers (see Recreation) under all three alternatives.

Marias/Teton Subbasin

Under the Consumptive Use Alternative, approximately 35,600 acres in the Marias/Teton Subbasin would be irrigated with reservation water, increasing irrigated acreage in the subbasin by 19 percent. Total subbasin acres of irrigated alfalfa would increase by about 33,500 acres by the year 2020. Most of this land is currently cropland and pasture (Table 6-18). A small portion of this land (12 percent) is already irrigated when water is available.

Under the Combination Alternative, the number of acres served with reserved water would be 30 percent of the acreage irrigated under the Consumptive Use Alternative. Approximately 10,600 acres would be irrigated, increasing subbasin acreage by 6 percent. Total irrigated alfalfa acreage would increase approximately 9,100 acres by the year 2020. Over 84 percent of this land is currently in cropland uses (Table 6-18), and 21 percent is irrigated when water is available.

Under the Instream Alternative, the number of acres irrigated with reserved water would be 12 percent of the acreage irrigated under the Consumptive Use Alternative. Ten proposed irrigation projects would serve 4,386 acres. This would increase Marias/Teton Subbasin irrigated acreage by 2 percent. Total subbasin irrigated alfalfa acreage would increase by approximately 3,800 acres (7 percent) by the year 2020. Virtually all of this land is currently in cropland use (Table 6-18). About half this land (2,240 acres) is already irrigated when water is available.

Table 6-18. Present land uses on areas where reservations for irrigation are proposed in the Marias/Teton Subbasin

	ALTERNATIVE		
Drainage	Consumptive Use	Instream	Combination
Marias			
cropped (acres)	26,299	1,365	6,160
pasture/range (acres)	825	223	1,635
total acreage	28,124	1,588	7,795
total number of projects	29	6	24
Teton			
cropped (acres)	6,093	2,778	2,778
pasture/range (acres)	1,363	20	20
total acreage	7,456	2,798	2,798
total number of projects	23	4	4
Marias/Teton Subbasin Totals			
cropped (acres)	32,392	4,143	8,938
pasture/range (acres)	3,188	243	1,655
total acreage	35,580	4,386	10,593
total number of projects	52	10	28

Middle Missouri Subbasin

About 120,200 acres in the Middle Missouri Subbasin would receive water for 44 proposed projects under the Consumptive Use Alternative. The largest project, BUREC, would provide supplemental water for 47,000 acres, and provide for the new irrigation of 6,600 acres in the Milk River drainage. This alternative would increase full-service irrigated acreage in the rest of the Middle Missouri Subbasin by 69,000 acres (63 percent subbasin increase).

Under the Combination Alternative, irrigated acreage in the subbasin would increase 50 percent. About 95,812 acres would be irrigated in 32 projects.

Under the Instream Alternative, 19 irrigation projects covering about 27,700 acres would increase subbasin irrigated acreage by 14 percent. The land use change, even though it is significant, is considerably less than under the other two alternatives.

Table 6-19 describes present land uses on areas where reservations for irrigation are proposed in the Middle Missouri Subbasin.

Table 6-19. Present land uses on areas where reservations for irrigation are proposed in the Middle Missouri Subbasin

	ALTERNATIVE		
Drainage	Consumptive Use	Instream	Combination
Missouri River—Belt Creek To Fort Peck Reservoir			
cropped (acres)	29,036	574	13,654
pasture/range (acres)	1,063	729	918
total acreage	30,099	1,303	14,572
total number of projects	19	10	16
Milk River			
cropped (acres)	53,600	0	53,600
pasture/range (acres)	0	0	0
total acreage	53,600	0	53,600
total number of projects	1	0	1
Judith River			
cropped (acres)	7,155	1,208	2,395
pasture/range (acres)	1,168	167	225
total acreage	8,323	1,375	2,620
total number of projects	22	8	14
Musselshell River			
cropped (acres)	3,119	0	0
pasture/range (acres)	0	0	0
total acreage	3,119	0	0
total number of projects	1	0	0
Fort Peck Reservoir			
cropped (acres)	23,115	23,115	23,115
pasture/range (acres)	1,905	1,905	1,905
total acreage	25,020	25,020	25,020
total number of projects	1	1	1
Middle Missouri Subbasin Totals			
cropped (acres)	116,025	24,897	92,764
pasture/range (acres)	4,136	2,801	3,048
total acreage	120,161	27,698	95,812
total number of projects	44	19	32

MISSOURI RIVER DRAINAGE - BELT CREEK TO FORT PECK RESERVOIR

Table 6-20 indicates irrigation projects that could directly affect the Upper Missouri Wild and Scenic River under each alternative. Project FEI-30 would be located within a river segment that is managed to protect its "wild" values near the mouth of Arrow Creek; FEI-10 would be located within a segment managed to protect its "recreational" values near the mouth of Wolf Creek; and FEI-20 would be located within a "scenic" segment just upstream from the Charles M. Russell Wildlife Refuge. The remaining 10 irrigation projects—CH-371, CHS-5, CH-21, CHS-6, CHI-10, CHI-21, CHI-22, CHI-30, CHI-40, and BUREC—would be located on land outside the designated wild and scenic river corridor, but their pumping stations would be located within it. Activities that adversely affect wild and scenic river values would require BLM approval and possible use of mitigating measures. Project FEI-30 would have to be reduced in size or moved to avoid running through Arrow Creek and a steep river bluff area.

MILK RIVER DRAINAGE

Under the Consumptive Use and Combination alternatives, the BUREC Virgelle project would divert water from the Missouri River to approximately 53,600 acres in the Milk River drainage, 47,000 acres of which are presently irrigated when water is available. This project would increase the reliability of irrigation water supplies to the Milk River basin, enabling ranchers to increase their alfalfa and other hay production. Approximately 6,600 acres of new irrigation would be developed along the proposed canal route between Big Sandy and Havre. While canal location from the Virgelle pumping station through Big Sandy to the Milk River has been mapped, no design work has been done for highway, railroad, and pipeline crossings. Also, the design

Table 6-20. Irrigation projects that could affect the Upper Missouri Wild and Scenic River

Consumptive Use	Combination	Instream	Location and type of affected area
BUREC	BUREC	—[a]	Irrigated land outside Upper Missouri Wild and Scenic River Corridor.
CH-21	CHI-21	CHI-21	
CH-371	—	—	
CHS-5	CHS-5	—	
CHS-6	—	—	
CHI-10	CHI-10	CHI-10	
CHI-21	CHI-21	CHI-20	
CHI-22	CHI-22	CHI-22	
CHI-30	CHI-30	CHI-30	
CHI-40	CHI-40	CHI-40	
FEI-10	FEI-10	FEI-10	Irrigated land within the recreational river corridor.
FEI-20	—	—	Irrigated land within the scenic river corridor.
FEI-30	FEI-30	—	Irrigated land within the wild river corridor.

a Indicates a project is not included in this alternative.

work for the 6,600 acres of new irrigation along the canal is not completed, making it difficult to assess associated impacts. The effects of canals used to transport water to Bowdoin National Wildlife Refuge are not known. The proposed pumping station just upstream from Virgelle could affect the Upper Missouri Wild and Scenic River Corridor and would require approval of the BLM. The federal legislation designating the wild and scenic river allows irrigation diversions that do not diminish wild and scenic river values. The Virgelle project is not included under the Instream Alternative.

JUDITH RIVER DRAINAGE

Approximately 1,200 acres of the 8,300 acres included in the Consumptive Use Alternative in this drainage are presently irrigated when water is available, compared to about 180 acres of the 2,600 acres in the Combination Alternative.

Under the Consumptive Use and Combination alternatives, project FE-141 is pinched among a reservoir, a creek, and a county road, and overlaps both Pine Creek and the county road. Project FE-431 is situated among rural subdivisions between Lewistown and its airport. The project might be converted to a subdivision before irrigation could begin. Projects FE-672 and FE-673 slightly encroach upon U.S. Highway 191 and would have to be modified. Project FE-673 is crossed by an electric transmission line that would preclude construction of this project as proposed.

MUSSELSHELL RIVER DRAINAGE

Under the Consumptive Use Alternative, project LM-20 would provide water later in the irrigation season for an estimated 3,119 acres that currently receive early season irrigation from high spring flows in the Musselshell drainage. This project involves storing Musselshell River water in abandoned underground coal mines during the winter and spring. This stored water would be pumped back into the river to supplement existing irrigation. The water could be used to irrigate land at any point along the river, making it difficult to identify effects on land use. It is possible that repeated dewatering of the mine for project LM-20 would weaken geologic structures, accelerating their collapse and cause the overlying land surface to subside. Various structures and county roads overlying the mines could be affected if the surface subsides. Wheaton and Van Voast (1989) discussed subsidence as part of their analysis of experimental mine pumping. Experimental pumping of water from the Jeffrey Mine (LM-20) revealed no sign of subsidence (Wheaton 1990). However, subsidence has been documented at the nearby Williams mine. The issue cannot be considered resolved without a comprehensive assessment by a mine stability specialist. This project is not included under the Instream or Combination alternatives.

FORT PECK RESERVOIR DRAINAGE AND SMALL TRIBUTARIES

Water levels in Fort Peck Reservoir already fluctuate widely, causing major changes in the shoreline. Primarily drought and downstream water demands have caused shorelines to move over one-half mile in some cases. Shoreline residents who use Fort Peck as a water source have to develop new intake structures or haul domestic water from elsewhere. The newly exposed shorelines have created extensive mud flats, causing livestock to become mired, fence lines to be extended, and reducing usability of the reservoir for stock watering. As mud flats dry out, dust storms reduce use of nearby grazing areas (Knudsen 1990). Under any of the three alternatives, water levels would drop by 1 foot or less, but would worsen these problems.

Under all three alternatives, project VAS-1 would irrigate 25,000 acres (Table 6-19). A large pumping station would be constructed for project VAS-1 on the shore of Fort Peck Reservoir south of the village of Wheeler in the Charles M. Russell National Wildlife Refuge. A 2-mile long pipeline would deliver the water to a 32-mile long series of canals that would supply 184 center pivots, irrigating an average of 140 acres each. The proposed canal system would cross several roads, a pipeline, and an existing aqueduct. The impact of this project probably would be substantial, and development of this project would be complex, given the multiple land ownerships. Residences and county roads are within proposed irrigation projects. Impacts on houses and roads could be avoided by locating center pivots away from them.

FISHERIES AND AQUATIC HABITAT

GENERAL IMPACTS AND CONSIDERATIONS

Reduced streamflow can decrease the habitat available to fish and aquatic organisms eaten by fish, resulting in lower numbers and weight of fish in a stream. The effect of reduced streamflow can be illustrated by comparing fish populations above and

below major diversions or by comparing populations before and after droughts. On the Musselshell River, the 1985 drought reduced brown trout populations by one-half near the Selkirk fishing access. This population decline was most noticeable in younger fish, with populations declining 72 to 93 percent, depending on age (DFWP undated). In another portion of the Musselshell, fish populations below the Deadmans Basin supply canal are about one-third those above the diversion (Vaughn and Fredenberg 1984). A large portion of the Musselshell is diverted throughout much of the year into the Deadmans Basin supply canal.

Rainbow trout numbers and size increased substantially between 1986 and 1987 in the Big Hole River near Jerry Creek, but decreased during the drought of 1988 (Vincent et al. 1989). Most of this decrease affected younger fish.

On the Beaverhead River below Clark Canyon Dam, the number and weight of brown trout greater than 18 inches has decreased as winter releases have been severely reduced (Vincent et al. 1989,1990). While the number of larger fish decreased, the population of smaller brown trout increased.

Aquatic habitat also is affected by reduced streamflow. Tennant (1976), with the assistance of state fisheries biologists, conducted detailed field studies on 11 streams east of the Continental Divide in three states, including Montana, and concluded that the condition of aquatic habitat varies with remarkable uniformity in proportion to the average annual flow. He found that excellent to outstanding habitat for most aquatic life forms would be maintained when a flow equalling 60 percent of the average annual flow was maintained instream. Tennant recommended at least 30 percent of average annual flow be retained instream to preserve good survival conditions for most aquatic life forms. The study suggested that 10 percent of the average annual flow was minimum for short-term survival of most aquatic life. Although these generalizations may not apply in all situations, they demonstrate how flows are related to aquatic habitat and fish populations in a general sense. It also points out that fish may survive for short periods despite low flows, but good survival conditions for aquatic life depend on adequate flow.

On most streams discussed in this chapter, not enough information is available to establish the exact relationship between flow rates and fish populations. Many factors interact to influence fish populations, including fishing pressure, reproductive success, and habitat conditions. Many of these factors interact in complex ways, allowing fish populations to increase or decline.

In this analysis, streamflow rates that maintain riffle areas and side- channel habitat are used as indicators of aquatic habitat conditions. These rates were determined by DFWP after field investigations. Generally, flows necessary to maintain good riffle habitat average 27 to 47 percent of the average annual flow (see Appendix B). Other methods are available to approximate the amount of flow necessary to support aquatic habitat on a given stream. The methods used by DFWP and BLM are discussed in Appendix B.

In general, impacts of reduced streamflows would be noticed most on streams where flows are sometimes so low that aquatic habitat is already being adversely affected. In some instances, additional depletions would reduce flows to nothing. As flows are severely reduced, the condition of fish would decline and some fish could die from increased water temperatures, lowered dissolved oxygen levels, and reduced food production. These effects could be long term if a cycle of extremely low flows followed by a gradual recovery of the fishery is repeated several times. The fishery could take several years to recover from the effects of a very low-flow year. Impacts of additional consumptive water uses would be minor if streamflows are maintained at levels that adequately protect aquatic habitat.

Fish numbers also could decrease if fishing pressure increases substantially. This could occur when use is displaced from one stream to another as a result of low flow. Such effects would be greatest under the Consumptive Use Alternative and smallest under the Instream Alternative.

Short-term increases in sediment loads which could occur during construction of facilities for irrigation or municipal water use also could damage aquatic habitat. Sediment from construction can settle out of the water farther downstream, blanketing the stream bottom, clogging spawning beds, and damaging invertebrate populations that serve as food for fish (EPA 1986). Filling the spaces between gravel in spawning beds also can decrease the survival of fish eggs. Proper construction timing and techniques discussed later in this chapter could reduce this impact.

Additional nutrients added to streams as a result of proposed consumptive uses could increase the growth of aquatic plants up to the point where detrimental effects occur. Plants, including algae, produce oxygen during the day but consume it at night. When growth becomes too rapid, large amounts of dissolved oxygen are used at night. This leaves less dissolved oxygen available for fish and other aquatic organisms. Not enough information is available for most streams to determine whether detrimental effects would occur from the addition of nutrients. However, decreasing flow during the summer and adding nutrients to streams that already have low summer dissolved oxygen levels would adversely affect aquatic life. Nutrient loading is discussed further under the water quality section.

Diversion structures associated with the larger projects could trap and kill fish, especially during periods of low flow when most of the river would be diverted. Proper design of diversion structures could reduce this impact.

Except as noted, municipal reservations would have only minor effects on aquatic habitat and fish populations.

Instream reservations would help preserve aquatic habitat and fisheries (described in Chapter Four), but would not necessarily prevent new water development. Flows in excess of instream reservations (Table 5-1) could still be impounded or diverted. Reservation of instream flows would not limit the exercise of existing water rights or offer protection from natural conditions that already cause severe low flows and adversely affect aquatic habitat (see Tables 4-2, 4-4, 4-6, and 4-8).

Storage Projects

Table 6-21 lists the 15 storage projects that have been proposed and indicates the likelihood that each would support a fishery. Most of these are small projects. As stated in the applications, the purpose of 10 projects is strictly storage for irrigation, and 7

Table 6-21. Likelihood of proposed storage projects supporting a fishery under the Consumptive Use, Instream, and Combination alternatives

Location of Proposed Storage Project	Alternative: Consumptive Use	Alternative: Instream	Alternative: Combination	Purpose
Gallatin River Drainage				
Bozeman	possible	possible	possible	Municipal
Teton River Drainage				
TE-361 - Spring Coulee	possible	——[a]	——	Irrigation
TE-591 - Gamble Coulee	possible	possible	possible	Irrigation
TE-401 - UT Teton River[b]	small	——	——	Irrigation
TE-581 - Gamble Coulee	great	——	——	Fish/wildlife or irrigation
TE-381 - Weatherwax Coulee	small	——	——	Irrigation
CH-641 - Alkali Coulee	great	great	great	Wildlife
Marias River Drainage				
Cut Bank	unknown	unknown	unknown	Municipal
CHFG-181 - Cut Bank Coulee	great	great	great	Fire protection & recreation
TO-421 - Timber Coulee	possible	——	possible	Irrigation
PO-91 - Laughlin Coulee	small	——	——	Irrigation
Judith River Drainage				
FE-81 - Wolf Creek	small	——	——	Irrigation
FE-141 - Wolverine Coulee	small	small	small	Irrigation
FE-161 - Warm Springs Cr.	small	——	small	Irrigation
Sun River Drainage				
LC-251 - UT Smith Creek[b]	small	——	——	Irrigation

[a] Blank space indicates the project is not included under that alternative.
[b] UT means unnamed tributary.

of these reservoirs would be emptied each year. It is unlikely that they would support a fishery over the long term. Three of the irrigation reservoirs could have enough water throughout most years to support a fishery if there are no other limiting factors such as poor water quality.

The purpose of three storage projects is for fish, wildlife, recreation, or fire protection. These projects might have enough water throughout the year to support a fishery.

Most storage projects that might support a fishery are included under the Consumptive Use Alternative. The fewest are included under the Instream Alternative (Table 6-21).

Fishery impacts of Bozeman's proposed dam are difficult to estimate because of uncertainties about reservoir operations. However, under all the alternatives, about 1.25 miles of stream habitat would be inundated. It is unknown if reservoir operation would sustain a long-term fishery in the reservoir or Sourdough Creek below the proposed dam. In Sourdough Creek near the National Forest boundary, the reservation might reduce flows to 11 cfs or less. Flows greater than 11 cfs are thought necessary to maintain good amounts of food-producing riffle areas (USGS 1989b). Flows now fall below 11 cfs during the fall and winter (USGS 1989b).

Impacts of the Consumptive Use, Instream, and Combination Alternatives

Gallatin River Drainage

In dry years, flows in lower portions of the Gallatin River now fall to less than the 500 cfs considered necessary for minimal aquatic habitat (Appendix C). Reservations for irrigation and municipal use in the Gallatin River drainage would further reduce flows below 500 cfs, as shown in Table 6-22 and Appendix C. This would worsen an already undesirable situation for aquatic habitat and might lower trout populations. These impacts would be greatest under the Consumptive Use Alternative and less under the Combination Alternative.

Only minor effects to aquatic habitat would occur under the Instream Alternative because it contains no irrigation projects.

Madison River Drainage

During August, a large irrigation project (GA-201) would divert an average of about 80 to 90 cfs from the Madison River at the Greycliff fishing access site between Ennis Lake and Three Forks. Project GA-201 is the only large proposed diversion from the Madison River and is included under the Consumptive Use and Combination alternatives.

Elevated summer temperature in Ennis Lake is a major limitation on trout populations below the dam. Reducing flow in the river might further elevate water temperatures and adversely affect the fishery, especially during August (Table 6-22). Project GA-201 is not included under the Instream Alternative, and this alternative consequently would not affect aquatic habitat.

The additional diversion of 0.85 cfs by West Yellowstone would reduce spawning habitat in the lower 150 feet of the stream flowing from Whiskey Spring. This spawning habitat would be affected equally under the Consumptive Use, Instream, and Combination alternatives.

Jefferson and Boulder River Drainages

In the Jefferson River drainage, irrigation projects under the Consumptive Use Alternative would increase the frequency of near-zero August flows near the mouth and would further damage aquatic habitat (Table 6-22 and Appendix C). Flows already drop to zero during August of very dry years. In July during very dry years (90th percentile flows), flows would drop from about 247 cfs to zero, damaging food-producing riffle areas and adversely affecting the fishery. Return flows from the proposed projects would do little to increase flows during the fall and winter.

Under the Consumptive Use Alternative, projects JV-201 and JV-202 near Waterloo would require diversions totaling a maximum of about 160 cfs from the Jefferson River. These projects would increase the frequency and duration of severely reduced summer flows such as those that occurred in the late 1980s, leaving only standing pools separated by dry or nearly dry riffles. Fish would die as they did during the drought of 1988. Projects JV-201 and JV-202 are not included under the Combination Alternative.

Projects included in the Combination Alternative would reduce average August flows in the Jefferson river by about 42 cfs. Existing August flows are near zero at the mouth of the Jefferson River in about 1 year out of 10. The proposed reservations would increase the frequency of these near-zero flow conditions (see Appendix C). In at least 2 years out of 10 flows would drop below minimum levels (about 550 cfs) thought necessary to sustain a low level of aquatic

habitat. This would damage aquatic habitat. In July, the river currently drops below 550 cfs. During the 2 driest years in 10, proposed withdrawals would reduce July flows from about 523 cfs to about 462 cfs. Return flows from the proposed projects would do little to increase flows during the fall and winter of dry years; consequently, there would be no substantial increase in habitat during winter to help offset the summer losses. None of the irrigation projects are included under the Instream Alternative and associated adverse effects to aquatic habitat would not occur.

Aquatic habitat in the Boulder River would be further reduced under both the Consumptive Use and Combination alternatives. Five proposed irrigation projects—JV-17, JV-18, JV-63, JV-80, and JV-81—would be located along the portion of the Boulder River that already has low flows during the summer. Additional flow reductions would adversely affect aquatic habitat and cause riffles to become dry or nearly dry more frequently. Under the Instream Alternative, average summer flows would not change and there would be no effect on aquatic habitat in the Boulder River.

Big Hole, Beaverhead, Ruby, and Red Rock River Drainages

In the Big Hole, Beaverhead, Ruby, and Red Rock river drainages, the only reservation requested for consumptive use is the Town of Dillon's application for municipal use. The slight reductions in flow on the Beaverhead River from this request would have a minimal effect on already poor aquatic habitat conditions during dry years.

Missouri River Drainage - Three Forks to Holter Dam

During the summer of dry years, flows in the Missouri River at Toston currently fall below optimal rates (about 2,400 cfs) needed to maintain aquatic habitat in riffles and below rates needed to maintain water in side channels (about 2,500 cfs). Side channels are important rearing areas for young trout during the summer. Table 6-22 indicates how summer flows near Toston would change during dry years under the Consumptive Use and Combination alternatives. After project development, portions of riffles would be exposed more frequently and for longer periods of time, reducing food-producing areas.

Table 6-22. Changes in flow affecting aquatic habitat in major rivers under the Consumptive Use and Combination alternatives[a]

Stream	Approximate flow rates considered optimal for existing habitat (cfs)[b]	Approximate flow rates providing minimal protection to aquatic habitat[b]	Average monthly flows (cfs) during the summer of dry years under existing conditions[c]		Average monthly flows (cfs) during the summer of dry years under Consumptive Use Alternative		Average monthly flows (cfs) during the summer of dry years under the Combination Alternative	
			July	August	July	August	July	August
Headwaters Subbasin								
Gallatin River near Logan	1,000	500	871	485	848	464	856	471
Madison River near Three Forks	900-1,100	NA	1,223	724	1,127	645	1,127	645
Jefferson River near Three Forks	1,100	550	523	172	255	0	523	172
Upper Missouri Subbasin								
Missouri River near Toston	2,400 over riffles 2,500 in side channels	NA	2,154	1,280	1,820	1,045	1,988	1,165
Missouri River below Holter Dam	2,700-2,900 over riffles 4,100 in side channels	NA	2,902	2,769	2,849	2,718	2,853	2,736
Smith River near Eden (above Hound Creek)	150	80	129	56	110	34	129	47
Dearborn River near the mouth	110	50	89	33	87	32	87	32
Sun River near Vaughn (below Muddy Creek)	220	130	240	312	137	265	215	300
Marias/Teton Subbasin								
Marias River above Tiber Reservoir	200	NA	399	95	382	74	386	79
Marias River near Loma (above Teton River)	560	320	596	472	310	294	533	434
Teton River near mouth	UNKNOWN	UNKNOWN	0	0	0	0	0	0
Middle Missouri Subbasin								
Judith River at mouth	300	160	308	238	226	168	269	211

[a] There would be no reductions to flows in the Missouri River and its tributaries above Canyon Ferry Dam during dry years under the instream alternative. Flow reduction in the Missouri River below Canyon Ferry Dam during dry years would be very small under the Instream Alternative.
[b] Source: DFWP 1989
[c] Based on DNRC modeling

Side-channel rearing habitat also would be dewatered more frequently and for longer periods of time. Adverse effects to riffle and side-channel habitat would be greatest under the Consumptive Use Alternative. Under the Instream Alternative, median flows would drop from 4,710 to 4,406 cfs in July and from 2,251 to 2,247 cfs in August, and would have a comparatively minor effect on aquatic habitat.

Releases of stored water have benefitted the fishery below Hauser Reservoir by providing more stable flows and water temperatures. However, in 5 years out of 10, flows in the 3-mile reach of the Missouri River between Hauser and Holter reservoirs already fall below the 4,878 cfs thought necessary for optimal brown trout spawning. Proposed uses under the Consumptive Use, Instream, and Combination alternatives would increase the occurrence of flows below 4,878 cfs and might adversely affect habitat available for brown trout migrating from Holter Lake to spawn in this reach of the river. This in turn might affect the numbers of brown trout in Holter Reservoir. Adverse effects would be most severe under the Consumptive Use, less under the Combination, and least under the Instream Alternative.

Table 6-23 indicates tributary streams in the Upper Missouri Subbasin where aquatic habitat could be adversely affected under the three alternatives.

Table 6-23. Streams in the Upper Missouri Subbasin where adverse effects to aquatic habitat may result from the Consumptive Use, Instream, and Combination alternatives

		Alternative						
	August flow (cfs)	Consumptive Use		Instream		Combination		
Stream	during dry years (80th percentile)	Project	Reduction in August flow (cfs)	Project	Reduction in August flow (cfs)	Project	Reduction in August flow (cfs)	Remarks
Warm Springs Creek	13	BR-44 BR-40 BR-41 BR-42 Total	9.35 1.87 7.48 1.05 19.75	BR-44 BR-40 BR-41 BR-42	9.35 1.87 7.48 1.05 19.75	BR-44 BR-40 BR-41 BR-42	9.35 1.87 7.48 1.05 19.75	Little is known about the fishery in Warm Springs Creek. There also is some uncertainty over the actual changes in flow because these projects would use water from deep artesian aquifers. If these flow reductions occur, aquatic habitat would disappear in dry years.
Deep Creek	18	BR-28 BR-29 Total	1.87 0.32 2.19	BR-28 —a	1.87 0	BR-28 —	1.87 0	The lower portion of Deep Creek frequently goes dry as water is intercepted by an irrigation canal. Additional reductions in flow may hinder DNRC's efforts to restore the fishery in the lower portion of the creek as required mitigation for changes in its operations at Toston Dam.
Hound Creek	22	CS-62 CS-63 CS-64 Total	0.50 0.35 0.36 1.21	— — —	0	CS-62 CS-63 CS-64	0.50 0.35 0.36 1.21	About 35 cfs is needed to maintain optimal aquatic habitat conditions. The additional reductions would slightly reduce aquatic habitat in riffle areas.
Big Coulee	3.46	TE-181 TE-183 Total	0.91 3.95 4.96	— —	0	TE-181 TE-193	0.91 3.95 4.96	Through changes in flow would have substantial effects on aquatic habitat, DNRC estimates winter flows near the diversions now approach zero, and it is unlikely this stream supports substantial game fish population.

[a] Blank space indicates a project is not included in that alternative.

Missouri River Drainage - Holter Dam to Belt Creek

By stabilizing flows and water temperatures, releases of water stored at upstream dams have benefitted the fishery in the Missouri River below Holter Dam. Here, flows of about 2,700 to 2,900 cfs are sufficient to maintain aquatic habitat in most riffles, and flows of approximately 4,100 cfs will maintain side channels used for spawning and rearing of young trout. Flows currently fall below these rates as shown in Appendix C. The proposed irrigation projects and municipal water uses under the Consumptive Use and Combination alternatives would slightly increase the frequency of flows below 2,900 cfs during the summer of dry years, slightly reducing food-producing areas. Flows would fall below 4,100 cfs more often during the summer and, as a result, side channels could be less usable for the rearing of trout. This effect would be very slight. Flows resulting from the Consumptive Use and Combination alternatives are shown in Appendix C.

Under the Instream Alternative, side-channel habitat reductions would be relatively small because the frequency and duration of flows below 4,100 cfs would not change much (see Appendix C).

Dearborn River Drainage

Under the Consumptive Use and Combination alternatives, project LCI-20 would reduce summer flows in the Dearborn River, which already has low flows in dry years. Approximately 110 cfs is necessary to maintain optimal flow conditions to protect aquatic habitat. At flows less than about 50 cfs, riffles are exposed, reducing areas capable of producing food for fish. In about 2 years out of 10, August through February flows currently fall below 50 cfs (Appendix C). Additional reductions would worsen this situation and slightly decrease aquatic habitat (Table 6-22) under the Consumptive Use and Combination alternatives. Aquatic habitat would not be adversely affected under the Instream Alternative because project LCI-20 would not be developed.

Smith River Drainage

Riffle areas in the Smith River above Hound Creek are already adversely affected by low flows. Roughly 80 cfs is needed to maintain low levels of riffle habitat in the Smith River above Hound Creek and 150 cfs to maintain near optimal habitat conditions (Table 6-22). Development of the proposed irrigation projects under the Consumptive Use Alternative would reduce flows during August of the 2 driest years in 10 from 56 cfs to about 46 cfs. During extremely dry conditions which occur 1 year in 10, August flows would be reduced from 24 cfs to about 14 cfs. This would reduce riffle habitat and adversely affect the fishery in the Smith River above Hound Creek.

Aquatic habitat and fisheries in the Smith River above Hound Creek would not be adversely affected by reservations under the Instream or Combination alternatives because projects proposed by the Meagher County Conservation District are not included.

Flow reductions would affect aquatic habitat in the lower portion of the Smith River under all alternatives. However, the effects of these flow reductions on aquatic habitat are not understood well because little information is available on instream flow needs and flows have not been gauged or estimated.

Table 6-23 indicates how aquatic habitat in Hound Creek would be affected under each of the alternatives.

Sun River Drainage

Severely reduced flows in the Sun River above Muddy Creek already have adverse effects on aquatic habitat during the summer, and additional diversions under the Consumptive Use Alternative would worsen this situation. Under the Instream and Combination alternatives, proposed projects that would divert flow above Muddy Creek are not included, and aquatic habitat would not be affected.

Return flows from the Greenfields Bench irrigation project seep into Muddy Creek which carries them to the lower Sun River in late summer. Though water quality is poor in these return flows, late summer flow rates in the lower Sun River are above those thought necessary (about 130 cfs) to provide a low level of protection to aquatic habitat as shown in Table 6-22. However, July flows currently fall to only 43 cfs 1 year in 10 (Appendix C) in the Sun River near Vaughn (below Muddy Creek). Here, additional irrigation would cause average July flows to cease in 1 year in 10 under the Consumptive Use Alternative and fall to only 20 cfs in 1 year in 10 under the Combination Alternative. Aquatic habitat would be adversely affected and water temperatures could increase and harm fish and other aquatic life under each of these alternatives. Under the Instream Alternative, flows would remain above 130 cfs in 5 years in 10 and existing low levels of aquatic habitat would be maintained.

Belt Creek Drainage

A resident trout and whitefish fishery exists in Belt Creek just above its mouth, where these species

spawn. Sauger migrate up Belt Creek from the Missouri River. Lower Belt Creek already has reduced flows during late summer. These low flows reduce aquatic habitat to marginal levels in dry years. Taken together, additional reductions from irrigation projects on Belt Creek under any of the alternatives would worsen the existing low-flow conditions and increase adverse impacts to aquatic habitat. Impacts would be most severe under the Consumptive Use Alternative, intermediate under the Combination Alternative, and least severe under the Instream Alternative.

Marias River Drainage

Roughly 200 cfs is thought necessary to provide adequate flows in riffles in the upper Marias, but flows currently fall below this level in about 2 years out of 10 between August and February. In 1 year in 10, there is no flow in some parts of the stream during August. Under the Consumptive Use Alternative, new water uses above Tiber Dam would cause slight to moderate decreases in summer flows in the Marias River, which would reduce the amount of food-producing riffle habitat. Under the Instream Alternative, additional impacts to aquatic habitat in the Marias River above Tiber Reservoir would be minor. Additional impacts to aquatic habitat from projects in the Combination Alternative would be intermediate between those from the Consumptive Use and Instream alternatives, as shown in Table 6-22 and Appendix C.

In Tiber Reservoir, new water uses allowed under any of the three alternatives would not reduce water elevations during the critical spawning season between April 15 and June 1 and probably would not affect spawning of forage fish.

A trout fishery has developed below Tiber Reservoir as a result of releases of stored water. Reservations under the Consumptive Use, Instream, and Combination alternatives would have relatively minor effects on this fishery.

In the lower portion of the Marias River, flows of 560 cfs are thought necessary to maintain optimal amounts of water over food-producing riffles, while flows below 320 cfs expose parts of these riffles. Water uses included under the Consumptive Use Alternative, primarily irrigation in project BSS-2, would cause July flows in the Marias to cease 1 year in 10. This would have a major adverse effect on aquatic habitat in this portion of the river unless water is released from Tiber Reservoir to mitigate this effect. Fish could be killed in the pumps of project BSS-2, though proper design of the intake could reduce the numbers.

Consumptive water uses included in the Instream Alternative would cause only slight adverse effects to aquatic habitat, assuming reservoir operations do not change. In dry years, summer flows would drop below 560 cfs but not below 320 cfs, meaning impacts would be no worse than moderate. Winter flows and habitat conditions would not change. Impacts of the Combination Alternative would be similar in type but slightly more than those described for the Instream Alternative, in Table 6-22 and Appendix C.

Table 6-24 indicates additional streams that would be adversely affected by proposed consumptive water uses in the Marias River drainage.

Teton River Drainage

The lower portion of the Teton River already has extremely low flows at times. Diversions in the upper portion of the drainage would worsen the chronic late summer low flows and adversely affect aquatic habitat in the lower Teton River. The lower portion of the river does not support a highly valued sport fishery. However, two species of special concern, the blue sucker and sturgeon chub, have been found between Choteau and the mouth of the Teton River. Both of these species are reported to prefer flowing water and could be adversely affected by additional consumptive water use.

Flows in the Teton River and Spring Creek could be reduced as groundwater is pumped for project TE-321 under any of the three alternatives. Spring Creek is a locally important trout fishery. The reduction in flow is not precisely known but could be as great as 3.74 cfs. Spring Creek is estimated to have a base flow of about 4.5 cfs. Severe reductions in habitat may result if 3.74 cfs is actually diverted.

Fisheries impacts of irrigation projects in Alkali Coulee (CH-641) and Spring Coulee (TE-361) are unknown.

Missouri River Drainage - Belt Creek to Fort Peck Reservoir

Between Belt Creek and the Marias River, about 3,700 cfs is needed in the Missouri River to maintain flow in food-producing riffle areas. About 4,500 cfs is needed to prevent side channels in this reach from

becoming excessively shallow. Side channels are important for rearing of young goldeye, bigmouth buffalo, smallmouth buffalo, and other small fish eaten by game fish. Table 6-25 shows how frequently flows would fall below 4,500 cfs and how they would change under each alternative. Flow reductions under the Combination Alternative would worsen aquatic habitat conditions to a lesser degree than the Consumptive Use Alternative, but more than under the Instream Alternative as shown in Table 6-25 and Appendix C.

In the section of the Missouri River between the Marias and Judith rivers, flow reductions would adversely affect riffle and side-channel habitat. In this reach, about 5,400 cfs is thought necessary to protect habitat in side channels, and roughly 4,300 cfs is needed to maintain water over riffle areas (Table 6-25). Water uses under the Consumptive Use Alternative would increase the frequency of low flows as shown in Table 6-25. Flows of 14,000 cfs or more are thought necessary for successful paddlefish migration in the spring. Consumptive water uses would slightly decrease

Table 6-24. Streams in the Marias/Teton Subbasin where adverse effects to aquatic habitat may occur under the Consumptive Use, Instream, and Combination alternatives

Stream	August flow (cfs) during dry years	Alternative: Consumptive Use — Project	Consumptive Use — Reduction in August flow (cfs)	Instream — Project	Instream — Reduction in August flow (cfs)	Combination — Project	Combination — Reduction in August flow (cfs)	Remarks
Cut Bank Creek at Cut Bank	35	GL-221 GL-11 Total	1.62 1.32 2.94	GL-221 GL-11	0 1.32	GL-221 GL-11	0 1.32	About 75 cfs is needed to maintain riffles, and flows now fall below this above Cut Bank. Additional depletions by the City of Cut Bank and projects GL-11 and GL-221 would further reduce flows and adversely affect aquatic habitat.
Two Medicine River	144	POI-10 PO-421 Total	1.34 1.19 2.53	—[a] —	0	POI-10 PO-421	1.34 1.19	Flows are now below rates thought necessary to provide good aquatic habitat (about 16.5 cfs). Consumptive water use would further reduce flows and might adversely affect aquatic habitat.
Laughlin Coulee	0.4	PO-91	0.25	—	0	—	0	The stream would be dewatered in 2 years out of 10, which would adversely affect aquatic habitat. It is not known whether this stream supports game fish.
Timber Coulee	0.1	TO-421	0.33	—	0	TO-421	0.33	Water would be pumped from 3 existing reservoirs. Flows in the creek are very low, and it is unlikely the creek supports populations of game fish.
Gamble Coulee	0.19	TE-581 TE-591 Total	0.28 3.91 13.88	— TE-591	0 3.91	— TE-591	0 3.91	Though changes in flow would have substantial effects on aquatic habitat, DNRC estimates winter flows near the diversions approach zero, and it is unlikely this stream supports large game fish populations.
Alkali Coulee	0.1	CH-641	0.04	CH-641	0.04	CH-641	0.04	Flows in Alkali Creek are very low, and it is not known if the creek supports a fishery. The depletions would adversely affect aquatic habitat in the stream. The proposed reservoir might support a fishery.

[a] Blank space indicates a project is not included in that alternative.

Table 6-25. Changes in flow affecting aquatic habitat in the Missouri River between Fort Benton and Fort Peck Reservoir under the Consumptive Use, instream, and Combination alternatives

Missouri River at:	Approximate flows (cfs) necessary to maintain aquatic habitat during certain period[a]			Percent of the time flow is equaled or exceeded under existing conditions[b]		Percent of the time flow is equaled or exceeded under the Consumptive Use Alternative		Percent of the time flow is equaled or exceeded under the Instream Alternative		Percent of the time flow is equaled or exceeded under the Combination Alternative	
	Purpose	Period	Flow	Period	Flow	Period	Flow	Period	Flow	Period	Flow
Fort Benton	Side channels	July 6 - August 31	4500	July	65	July	59	July	64	July	61
				August	48	August	39	August	46	August	45
	Riffles	September 1 - March 14	3700	September	88	September	82	September	86	September	85
				October	91	October	90	October	91	October	91
				November	92	November	92	November	92	November	92
				December	92	December	91	December	92	December	92
				January	85	January	84	January	85	January	85
				February	89	February	88	February	89	February	89
				March	94	March	94	March	94	March	94
Virgelle	Paddlefish migration	May 19 - July 5	14000	May	36	May	34	May	35	May	35
				June	46	June	44	June	46	June	46
	Riffles	July 6 - August 31	5400	July	67	July	57	July	66	July	65
				August	49	August	32	August	49	August	46
	Side channels	September 1 - March 14	4300	September	83	September	70	September	80	September	78
				October	90	October	88	October	89	October	88
				November	92	November	92	November	92	November	92
				December	85	December	84	December	85	December	84
				January	79	January	79	January	79	January	79
				February	86	February	85	February	86	February	85
				March	92	March	91	March	92	March	92
Landusky (Fred Robinson Bridge)	Paddlefish migration	May 19 - July 5	15302	May	31	May	30	May	31	May	30
				June	51	June	48	June	51	June	49
	Riffles	July 6 - August 31	5800	July	73	July	63	July	71	July	66
				August	51	August	35	August	50	August	46
	Side channels	September 1 - March 14	4700	September	81	September	69	September	81	September	76
				October	89	October	86	October	89	October	87
				November	92	November	92	November	92	November	92
				December	86	December	86	December	86	December	86
				January	77	January	76	January	77	January	77
				February	83	February	80	February	83	February	83
				March	97	March	97	March	97	March	97

a Source DFWP 1989
b Based on results of DNRC computer modeling

the frequency of flows over 14,000 cfs and might adversely affect paddlefish migration. Flow reductions under the Combination Alternative would worsen aquatic habitat conditions to a lesser degree than the Consumptive Use Alternative, but more than under the Instream Alternative as shown in Table 6-25 and Appendix C.

In the Missouri below the confluence of the Judith River, about 5,800 cfs is needed to maintain side-channel habitat and about 4,700 cfs is needed to maintain water over riffles at Cow Island.Two species of special concern, the sicklefin chub and the sturgeon chub, depend upon riffle habitat in the Cow Island area. Near Landusky, July flows presently fall below 5,800 cfs about 27 percent of the time and August flows fall below this rate about 49 percent of the time. Flows fall below 4,700 cfs as shown in Table 6-25. Under the Consumptive Use Alternative, water uses would increase the frequency of flows below those needed to maintain side-channel and riffle habitat and decrease the periods that spring flows exceed the 15,300 cfs needed for paddlefish migration. Flow reductions under the Combination Alternative would worsen aquatic habitat conditions to a lesser degree than the Consumptive Use Alternative, but more than under the Instream Alternative as shown in Table 6-25 and Appendix C.

The pallid sturgeon is an endangered species found in the Missouri River between the Marias River and Fort Peck Dam. At this time, it is not possible to completely predict how consumptive water uses under each of the three alternatives would affect this species because so little is known about its biology and habitat requirements. It is likely that the U.S Fish and Wildlife Service would prepare biological assessments in conjunction with the Corps 404 permit process for streambed disturbance prior to project development. These assessments would address adverse effects on this species.

Pallid sturgeon can hybridize with shovelnose sturgeon, and the two species are thought to use similar spawning areas. A recent study has shown that during spawning, shovelnose sturgeon congregate near Boggs Island just downstream from BUREC's proposed Virgelle diversion. The BUREC project is included under the Consumptive Use and Combination alternatives. BUREC proposes to excavate the river bottom for an infiltration gallery. This excavation might lead to sedimentation in an area where shovelnose sturgeon spawn. A pallid sturgeon was captured near this area in 1978 (Clancy 1991), raising the possibility that they also may use this spawning habitat.

Paddlefish also are known to congregate at or very near to BUREC's proposed Virgelle diversion during the spawning season. These concentration areas may be adversely affected by sedimentation from instream construction activities. Construction methods such as the use of sheet pilings for coffer dams could be used to reduce sedimentation, and constructing during the low-flow period could reduce impacts to spawning sturgeon and paddlefish.

Judith River Drainage

Flows below 300 cfs in the lower portion of the Judith River sometimes expose riffle areas but do not fall below 160 cfs, which would expose extensive riffle areas (Appendix C). Proposed uses under the Consumptive Use Alternative would reduce July flows by about 80 to 90 cfs and reduce August flows by about 70 to 80 cfs, further reducing riffle habitat. Under the Instream and Combination alternatives, consumptive water use would affect habitat conditions but not to the point where extensive riffle dewatering would occur (Table 6-22).

Project JBI-2 would reduce flows in the Judith River above the confluence of Big Spring Creek under the Consumptive Use Alternative. Flows in this reach of the Judith River become very low during dry years. The diversion structure for this project is located just below an outlet canal from Ackley Lake. In dry years flows in the Judith River, measured at Utica several miles above the project, would be reduced from 13 to 7 cfs and would adversely affect aquatic habitat. The effect might be less than this because the project is situated below the outlet.

Table 6-26 lists other streams in the Judith River drainage where moderate reductions in aquatic habitat would occur.

Musselshell River Drainage

Under the Consumptive Use Alternative, it is not possible to determine all the fisheries impacts that would result from the Coal Mine Project (LM-20) until the points of diversion for land to be irrigated have been identified. In theory, fisheries could be affected anywhere in the basin as a result of a water exchange that could result from the Coal Mine Project. If the Coal Mine Project operates as proposed, it could cause an adverse impact to aquatic habitat by changing flow patterns in the Musselshell River during the spring and summer. From October through January, flows would increase due to irrigation return flow, providing small benefits to aquatic habitat.

Table 6-26. Streams in the Middle Missouri Subbasin which may experience adverse effects to aquatic habitat under the Consumptive Use, Instream, and Combination alternatives

		Alternatives						
		Consumptive Use		Instream		Combination		
Stream	August flow (cfs) during dry years	Project	Average reductions in August flow (cfs)	Project	Average reductions in August flow (cfs)	Project	Average reductions in August flow (cfs)	Remarks
Wolf Creek	6.1	FE-81	2.33	—[a]	0	—	0	In dry years, flows would fall from 6.1 to 3.8 cfs and would have minor to moderate impact on aquatic habitat. While the creek supports minnows, it is not known whether game fish are present.
Little Casino Creek	0.8	FE-431	0.43	FE-431	0.43	FE-431	0.43	In dry years, flows in Little Casino Creek would be halved, adversely affecting aquatic habitat. The stream supports a few brook trout.
Dawkins Spring (Olsen Creek)	9.0	FE-671 FE-672 Total	3.43 2.05 5.48	FE-671 FE-672 Total	3.43 2.05 5.48	FE-671 FE-672 Total	3.43 2.05 5.48	Flows in Olsen Creek, a spring creek, would be reduced to less than half in dry years, adversely affecting aquatic habitat and possibly harming the trout population.
Louse Creek	0.2	JB-21 JB-231 JB-232	0.10 0.34 0.34	— JB-231 JB-232	0 0.34 0.34	JB-21 JB-231 JB-231	0.10 0.34 0.34	Flows in Louse Creek are predicted to cease in about 5 years in 10. Lack of flow could harm the brook trout population near the agricultural experiment station.
Running Wolf Creek	2.7	JB-261 JBS-3 Total	0.16 1.75 1.91	— JBS-3	0 1.75	JB-261 JBS-3 Total	0.16 1.75 1.91	Projects JB-261 and JBS-3 each require a peak diversion of more than 3 cfs which could dry up the creek. However, Running Wolf Creek currently goes dry a short distance downstream of JBS-3.
Little Trout Creek	0.2	JB-309	0.18	—	0	—		Flows in Little Trout Creek are expected to cease during July in at least 2 years in 10. Lack of flow would adversely affect aquatic habitat. There are just a few trout in the stream which is dewatered in very dry years.
Unnamed tributary of Campbell Coulee	0.2	FE-42	0.18	—	0	—	0	Aquatic habitat and aquatic animals would be adversely affected, but this stream probably does not support game fish. Near its mouth, a few minnows inhabit the stream.
Wolverine Creek	0.4	FE-141	1.72	FE-141	1.72	FE-141	1.72	At the project site, there was no flowing water in June 1990, and this project probably will have minor effects on aquatic habitat.
Unnamed tributary of Ross Fork Creek	0.4	FE-673	0.61	FE-673	0.61	FE-673	0.61	While this project would adversely affect aquatic habitat, the stream does not support game fish.
McCarthy Creek	0.3	JB-111	0.58	—	0	JB-111	0.58	This project could reduce flows in McCarthy Creek to 0 cfs in dry years and adversely affect aquatic habitat, but it is not known whether the stream supports any fish.
Warm Springs Creek	90.0	FE-561 FEI-40 Total	2.22 7.31 9.73	— —	0 0	— FEI-40	0 7.31	The effects of this project near the project site are small, but the effects to aquatic habitat in the lower portion of Warm Springs Creek are not known.
Unnamed Tributary of Big Sag Creek	0.4	CH-551	0.24	CH-551	0.24	CH-551	0.24	This project would adversely affect aquatic habitat, but is unlikely to affect fish.
Shonkin Creek	7.0	CH-201	0.23	CH-201	0.23	CH-201	0.23	The effects of this project at the project site are small, but the effects to aquatic habitat in the lower portion of Shonkin Creek are not known.

[a] Blank space indicates a project is not included under that alternative.

There would be no adverse effects to aquatic habitat in the Musselshell drainage under the Instream or Combination alternatives.

Fort Peck Reservoir

Various consumptive uses proposed under all alternatives would reduce Fort Peck Reservoir levels by 1 foot or less (Appendix C). Such reductions would worsen already low water levels and decrease the reservoir surface area slightly which, in turn, would slightly decrease reservoir habitat.

WILDLIFE

General Impacts and Considerations

Proposed irrigation projects would affect wildlife by altering habitat and decreasing streamflows during the summer low-flow period. Habitat would be altered by conversion of native plant communities to agricultural crops and from loss of riparian cottonwood communities. Reduced streamflows during the summer growing season could stress in-stream and riparian vegetation by lowering groundwater within rooting zones of plants adapted to high groundwater tables.

Conversion of native plant communities to agricultural crops would deprive birds such as sharp-tailed grouse, sage grouse, and meadowlark of nesting and foraging habitat. Some species, however, would use agricultural crops as an additional source of food. Both sharp-tailed grouse and sage grouse eat alfalfa, and sharp-tailed grouse favor small grains. Field surveys have not been conducted to identify grouse courtship grounds (leks) and nesting areas on or near proposed projects.

Impacts to sharptails and sage grouse also could result if agricultural development affects leks. Leks could be rendered inactive or partially inactive if they are greatly altered or affected by increased human or livestock activity during the critical spring courtship and breeding season.

Conversion of native grasslands to irrigated croplands on big game winter range could reduce the amount of forage available to wintering elk and deer. On winter range with native plant communities, elk and deer eat shrubs and dried native grasses that remain palatable through the winter. Conversion of native shrublands and grasslands to hay or other crops could reduce winter forage, particularly if crops are harvested late in the season. Losses in native vegetation could stress wildlife during the winter and increase depredation on crops and hay. Acreages of native plant communities that would be converted on big game winter ranges are shown for proposed irrigation projects (Table 6-27).

Table 6-27. Acres of native vegetation on big game winter ranges converted to cropland

Project	Consumptive Use Alternative	Instream Alternative	Combination Alternative
Headwaters Subbasin			
GA 35	30	0	30
GA 46	60	0	60
GA 79	100	0	100
GA 92	60	0	60
GA 110	4	0	0
GA 130	20	0	0
GA 143	8	0	8
GA 201	1,990	0	1,990
JV 201	3,175	0	0
Subtotal	5,447	0	2,248
Upper Missouri Subbasin			
BR 5	182	182	182
BR 11	60	60	60
BR 35	250	250	250
BR 103	1,700	0	0
BR 104	1,095	0	0
BR 107	140	140	140
BR 108	115	115	115
BR 109	130	130	130
BR 111	40	0	0
LC 251	18	0	0
CS 62	59	0	59
CS 64	42	0	42
MEI 11	80	0	0
MEI 12	165	0	0
MEI 20	191	0	0
Subtotal	4,267	877	978
Marias/Teton Subbasin			
TO 221	66	0	66
LI 91	60	0	60
TEI 20	9	0	0
CH 511	82	0	82
CHI 21	80	80	80
CHI 22	144	144	144
CHI 72	46	0	0
CHI 80	53	0	0
BS 31	32	0	0
Subtotal	878	350	631
Middle Missouri Subbasin			
CH 541	13	0	13
FE 81	4	0	0
FEI 30	54	0	54
Subtotal	71	0	67
GRAND TOTAL	10,663	1,227	3,924

Source: Montana Department of Fish, Wildlife and Parks.

Increased acreages of agricultural crops would attract big game animals, particularly during the winter and spring. Depredation by game animals on crops is a frequent landowner complaint in all of the Missouri River subbasins. Both elk and deer feed on hay stored for livestock and graze on winter wheat and alfalfa when it greens up in the spring. Pronghorn also are attracted to wheat, alfalfa, and other broad-leafed crops. Wildlife damage to crops often requires measures to frighten animals away from problem areas, and if these measures are not sufficient, special hunting seasons may be necessary to kill problem animals.

DFWP has identified proposed irrigation projects with a high potential to sustain crop damage from wildlife (Table 6-28). Most areas identified are near or within existing winter ranges. Existing croplands and hayfields near the proposed irrigation projects also have a history of game damage complaints.

Birds of prey (raptors) could be affected by development of irrigation projects through disturbance during the nesting and brood rearing period (May through August). Species nesting on or near the ground, such as the northern harrier, ferruginous hawk, and burrowing owl, could be displaced from converted rangeland. Tree or cliff-nesting raptors, such as red-tailed hawk, Cooper's hawk, prairie falcon, Swainson's hawk, and golden eagle, also could be displaced from nest sites if agricultural activities such as movement of irrigation structures, plowing, and cultivating were to take place close to nests during the nesting and brood rearing periods. Raptors also could be electrocuted if they land on electric lines and poles that supply power to irrigation projects if the poles and lines are not constructed to prevent raptor fatalities. No comprehensive field surveys have been conducted to determine raptor use near proposed projects.

Reductions in streamflow due to increased irrigation could increase waterfowl deaths by predation. Geese and ducks nesting on islands would be more vulnerable if instream flows were to decrease during the brood rearing period (March and April for geese and April, May, and June for ducks). Most Canada goose broods hatch in the Missouri River during the last week of April or the first week of May, whereas ducks usually hatch during the last of May and first 2 weeks of June. Both geese and ducks would be less vulnerable to nest predation after hatching.

Impacts to wildlife can result if very low streamflows or periodic cessation of surface flow reduce food availability and render aquatic wildlife more susceptible to predation. Mink, raccoon, and river otter rely on fish, molluscs, amphibians, crayfish, and other aquatic invertebrates for food. Very low flows or periodic drying up of streams greatly reduce populations of aquatic organisms that are food for mink, raccoon, and otter.

Beaver and muskrat live in lodges or in burrows in banks with water submerging the burrow entrance. Low streamflows increase the potential for burrows to be entered by predators. Reduced water depths in streams also expose muskrat and beaver to increased predation while they are in the stream foraging.

Impacts of municipal water withdrawals on wildlife would be negligible except for Bozeman's proposed dam on Sourdough Creek. Approximately 1.25 miles of riparian habitat used by moose and white-tailed deer would be inundated. Approximately 118 acres of elk winter range also would be flooded by the reservoir.

Species of Special Concern

Conversion of native plant communities to croplands could destroy nesting habitat of the following species of special concern: ferruginous hawk, upland sandpiper, long-billed curlew, burrowing owl, mountain plover, bobolink, and Brewer's sparrow.

Impacts of the Consumptive Use, Instream, and Combination Alternatives

Headwaters Subbasin

Impacts to big game animals would result from converting approximately 5,447 acres of native vegetation on winter range to cropland under the Consumptive Use Alternative and 2,248 acres under the Combination Alternative. No winter range would be affected by the Instream Alternative. Cultivation of areas with native vegetation would reduce the abundance of native big game forage plants.

Under the Consumptive Use and Combination alternatives, streamflow reductions in the Boulder River and lower Jefferson River probably would reduce fish populations. Fish are a common food for wintering bald eagles. Decreases in fish populations

Table 6-28. Irrigation projects likely to increase game damage complaints

Project	Species affected by Consumptive Use Alternative	Species affected by Instream Alternative	Species affected by Combination Alternative
Headwaters Subbasin			
GA 92	WTD[a], MD[b], A[c]	None	WTD
GA 151	WTD, MD, E[d]	None	WT, MD, E
GA 143	WTD	None	WTD
GA 79	WTD	None	WTD
GA 81	WTD	None	WTD
GA 35	MD	None	MD
GA 201	MD, WTD, A	None	MD, WTD, A
JV 25	MD, WTD, A	None	MD, WTD, A
JV 95	MD, WTD, A	None	MD, WTD, A
JV 202	WTD, A	None	WTD, A
JV 63	MD, WTD, A	None	MD, WTD, A
JV 80	MD, WTD, A	None	MD, WTD, A
JV 81	MD, WTD, A	None	MD, WTD, A
Upper Missouri Subbasin			
BR 11	MD, A	MD, A	MD, A
BR 12	MD, A	MD, A	MD, A
BR 14	MD, A	MD, A	MD, A
BR 28	MD, A	MD, A	MD, A
BR 35	MD, WTD, A	MD, WTD,A	MD, WTD, A
BR 44	MD, WTD, A	MD, WTD,A	MD, WTD, A
BR 101	MD, WTD, A	None	MD, WTD, A
BR 103	MD, WTD, A	None	MD, WTD, A
BR 106	MD, WTD, A	MD, WTD, A	MD, WTD, A
BR 107	MD, WTD, A	MD, WTD, A	MD, WTD, A
BR 108	MD, WTD, A	MD, WTD, A	MD, WTD, A
BR 109	MD, WTD, A	MD, WTD, A	MD, WTD, A
BR 110	A, MD	A, MD	MD, WTD, A
BR 104	E	None	None
BR 111	E	None	None
BR 5	WTD	WTD	WTD
BR 29	WTD	None	None
BR 35	WTD	WTD	WTD
BR 50	WTD	WTD	WTD
CS 21	WTD	None	None
CSI 71	WTD	None	None
CS 471	None	None	None
CS 31	WTD	None	None
CS 51	WTD	None	None
CS 171	WTD	None	None
CS 52	WTD	None	None
CS 231	WTD	None	None
CSI 81	WTD	None	WTD
Marias-Teton Subbasin			
BS 2	WTD, A	None	None
BS 31	WTD, A	None	None
BS 32	WTD, A	None	WTD, A
PO 251	MD, E	None	MD, E
TO 211	MD, A	None	None
TO 221	MD, A	MD, A	MD, A
TO 341	MD, A	None	MD, A
TO 342	MD, A	None	None
TO 421	MD, A	None	MD, A
LI 91	MD, A	None	MD, A
LI 161	MD, A	None	MD, A
LI 261	MD, A	None	MD, A
LI 262	MD, A	None	MD, A
LI 263	MD, A	None	MD, A
TE 81	MD	None	None
TE 101	MD	MD	MD
TE 281	MD	None	None
TE 282	MD	None	None
TE 411	MD	None	None
TEI 20	MD	None	None
TEI 40	MD	None	None
TE 321	MD, E	MD, E	MD, E
TEI 50	MD, E	None	None
TEI 60	MD, E	None	None
TEI 70	MD, E	None	None
Middle Missouri Subbasin			
FEI 10	MD, WTD	MD, WTD	Md, WTD
FEI 20	MD, WTD, E	None	None
FEI 30	MD, WTD	None	MD, WTD
VAS 1	MD, A	MD, A	MD, A

a WTD = white-tailed Deer
b MD = mule Deer
c A = antelope
d E = elk

Source: Montana Department of Fish, Wildlife and Parks

might cause bald eagles to move to areas with higher fish populations or cause them to shift their diet to other winter foods such as carrion, rodents, or waterfowl. Because bald eagles are mobile and eat a variety of foods, impacts of seasonally reduced streamflows and associated reductions in fish populations would be negligible.

Upper Missouri Subbasin

Under the Consumptive Use Alternative, impacts to big game animals would be caused by converting approximately 4,267 acres of native vegetation on winter range to cropland; 978 acres would be converted under the Combination Alternative, and 877 acres would be converted under the Instream Alternative. This conversion could reduce the abundance of natural winter foods of big game animals (Table 6-27).

According to DFWP (1989a), the following instream flows are necessary to protect nesting Canada geese: 3,550 cfs for the Missouri River between Holter Lake and Great Falls and 4,887 cfs for the Missouri River between Great Falls and the confluence with the Marias River.

Under present streamflow conditions, flows in the Missouri River from Holter Lake to Great Falls are inadequate to protect nesting geese 2 out of 10 years in March and 1 out of 10 years in April, May, and June. With the Consumptive Use and Combination alternatives, instream flows would be too low to protect goose nests 2 out of 10 years during March, May, and June. Reservations included under the Instream Alternative would have little effect on nesting geese.

Marias/Teton Subbasin

Irrigation projects included under the Consumptive Use Alternative would cause impacts to big game animals by converting approximately 878 acres of native vegetation on winter range to cropland (Table 6-27), compared to 631 acres under the Combination Alternative, and 350 acres under the Instream Alternative. Losses in winter forage would result from removal of native shrubs and grasses.

A sage grouse lek in Pondera County (PO-91) would be affected under the Consumptive Use Alternative, but this project is not included under the Instream and Combination alternatives.

Streamflows in the Marias River below Tiber Reservoir have been too low for maximum protection of goose nesting 5 out of 10 years during March, April, and May. Projects included under the Consumptive Use, Combination, or Instream alternatives would not change existing conditions for protection of goose nesting on the Marias River.

Grizzly bear habitat along the Teton River would be altered by projects TEI-70, TEI-60, and TEI-50 which are included in only the Consumptive Use Alternative. Converting 1,136 acres of native vegetation to cropland probably would have minor impacts on grizzly bear. Grizzly bears periodically using the Teton River floodplain as a feeding and movement corridor typically have home ranges of 87 to 318 square miles (55,680 to 203,520 acres) (Interagency Grizzly Bear Committee 1987). The area that would be converted from native vegetation would comprise only about 0.5 to 2.0 percent of grizzly bear home range in this area.

Middle Missouri Subbasin

Sufficient information on the location of project land for BUREC's Virgelle diversion is not available to allow detailed analysis of wildlife and vegetation impacts. It is anticipated that a complete EIS would be required prior to project construction.

The Consumptive Use, Combination, and Instream alternatives would cause minor impacts to big game animals by converting less than 75 acres of native vegetation on winter range to cropland in this subbasin (Table 6-27).

Construction of irrigation pumping facilities on rivers, streams, and reservoirs in this subbasin under the Consumptive Use, Instream, and Combination alternatives might adversely affect nesting of endangered least tern and threatened piping plover. Field studies have not been conducted to determine if these species are present near proposed irrigation projects.

VEGETATION

General Impacts and Considerations

Impacts to vegetation would result from replacement of natural plant communities with agricultural crops, inundation of riparian and upland communities by reservoirs, and increased proliferation of noxious weeds. Conversion of native plant communities to crops would remove trees and shrubs in riparian areas and grassland and sagebrush-grasslands on

upland sites. Removal of plant communities would decrease food and cover for many species of wildlife, increase the potential for soil erosion, and detract from aesthetic and recreational qualities of some areas.

Construction of a reservoir on Sourdough Creek for the Bozeman municipal water supply and another on Cut Bank Creek (CH-181) would flood a total of about 120 acres of native plant communities. Riparian and upland communities would be lost and unvegetated mudflats would be created by reservoir drawdowns. These unvegetated areas would have a high potential for invasion by weeds when reservoir levels are lowered. There would be little potential for growth of desirable shoreline plants such as willows, sedges, and rushes, due to the seasonal fluctuations in water levels. Control of noxious weeds may be required on and along reservoir shorelines.

Riparian and wetland plant communities could become stressed due to moisture deprivation, species diversity would be lost, and population compositions would be changed by altered groundwater levels brought about by streamflow depletions. Diversion of surface water for irrigation would reduce streamflows and shallow groundwater levels under floodplains.

Wetland species such as sedges and rushes typically grow along small streams on soil saturated by groundwater within 6 inches to 1 foot of the soil surface. Cottonwoods, willows, green ash, and other broad-leafed species typically growing along larger rivers and streams require groundwater within their root zones during the growing season. Substantial decreases in streamflow that would lower shallow groundwater levels below the root zones of riparian and wetland plant communities would stress or kill some of these plants. The severity and extent of stress would depend on the frequency and duration of low water periods.

It is difficult to predict the impacts of streamflow depletions on mature riparian cottonwood communities. Observations of riparian forests along the Musselshell and Teton rivers, two streams with a history of dewatering, do not indicate that low streamflows have adversely affected cottonwood and other riparian communities. DFWP wrote in its application for instream flow reservations that "The Musselshell River provides one of the richest and most diverse riparian ecosystems in Montana." Apparently, the diverse riparian communities continue to thrive in spite of severe streamflow reductions on a regular basis.

It is unlikely that any of the alternatives would significantly affect tree-dominated riparian communities along major rivers and streams; however, adverse impacts on wetland and riparian species may occur on small streams and springs that would be severely dewatered in 2 out of 10 years. Many riparian areas along small streams, which do not regularly have spring floods, are vegetated by wet meadows of sedges, rushes, and grasses. These shallow-rooted plants would suffer from lack of water if stream surfaces were to drop as little as 6 inches during the growing season. Stressed by frequent low water conditions, moisture-loving plants eventually would be replaced by plants with greater drought tolerance. Plants likely to increase on dewatered riparian areas and wetlands include Kentucky bluegrass, western wheatgrass, foxtail barley, burdock, and other forbs and grasses adapted to intermediate soil moisture levels.

Sensitive Species

No Montana plants are federally listed as threatened or endangered species, so none would be affected by the water reservations. Eleven plants considered by the Montana Natural Heritage Program to be imperiled or rare in Montana may grow on some areas that would be converted to cropland (Table 4-32); however, field surveys of proposed projects have not been conducted to determine whether specific sensitive plant populations would be affected.

The Montana Natural Heritage Program also is in the process of identifying and designating native plant communities that may be rare or imperiled in Montana. Sufficient data do not yet exist to determine whether any rare or imperiled plant communities would be affected by the proposed projects.

Conversion of native plant communities would increase the risk of spreading noxious weeds. Removal of native vegetation and soil cultivation provide favorable growing conditions for noxious weeds which are effective invaders of disturbed sites. Noxious weeds also become established from planting of croplands with seeds contaminated with noxious weed seeds. Weeds growing from seeds unintentionally planted on croplands could spread to adjacent noncultivated native plant communities. On cropland, weeds reduce plant yields. On rangeland, they reduce the abundance of native plant species. Weed control could be necessary on both types of land.

Currently, the most effective method of noxious weed control is by application of herbicides. Herbicides applied to kill noxious weeds also may kill other desirable nontarget plants which provide food and habitat for wildlife.

HISTORICAL, ARCHAEOLOGICAL, AND PALEONTOLOGICAL RESOURCES

GENERAL IMPACTS AND CONSIDERATIONS FOR THE CONSUMPTIVE USE, INSTREAM, AND COMBINATION ALTERNATIVES

The most likely impacts to historical, archaeological, or paleontological resources would be the loss of information or site qualities through indirect or direct site disturbance when irrigation or municipal projects are developed. The potential for this loss is greatest on undisturbed rangeland and pastureland. Impacts would be considered significant when the lost information has the potential to provide further understanding of the past or where a site would be disturbed, destroyed, or altered to the point that it would no longer be eligible for listing on the National Register of Historic Places. Direct disturbance could occur through cultivation or irrigation and during construction of wells, canals, pipelines, and diversion structures. Indirect disturbance may occur through increased wind or water erosion resulting from cultivation or irrigation. Other indirect effects such as vandalism or unauthorized collection of artifacts are less likely because most projects would be on private land and access would be restricted.

There is some potential for new site discovery during project development, particularly for projects on undisturbed rangeland or pasture. The potential for impacts could be reduced by a qualified archaeologist or historian collecting and recording important information.

Under the Montana Antiquities Act, the Department of State Lands would be required to evaluate sites on state land and devise methods to retrieve or protect the information. Under the National Historic Preservation Act and the Archaeological and Historic Preservation Act, BLM or other federal land- managing agencies would evaluate sites on federal land and devise methods to retrieve or protect the information contained there. Sites on private land would not be evaluated unless the landowners have it done.

Adverse effects on paleontological resources would result if fossils of scientific importance were lost. Most of the areas affected by the proposed projects have not been inventoried for paleontological resources. Most of the significant fossil discovery in the basin is outside of the proposed projects. Project development could lead to discovery of new fossil sites. Discovery of new sites that contribute knowledge of vertebrate species and plant or other life forms would be a beneficial effect if the information contained at such sites were recovered.

The reservation of water for instream flow purposes would have no foreseeable effects on historical, archaeological, or paleontological resources beyond those occurring at present. Except as otherwise noted, municipal reservations would not affect known resources.

IMPACTS OF THE CONSUMPTIVE USE, INSTREAM, AND COMBINATION ALTERNATIVES

GALLATIN RIVER DRAINAGE

No known archaeological, historical, or paleontological sites would be affected by irrigation projects under the Consumptive Use, Instream, or Combination alternatives. Both Bozeman and Belgrade have sites listed on the National Register of Historic Places, but none of these would be directly affected. Several sites are located near the City of Bozeman's proposed project, but additional fieldwork would be required to determine the importance and whether retrieval of information and artifacts is necessary. Irrigation projects developed under the Consumptive Use and Combination alternatives could result in discovery of new sites during conversion of pasture or rangeland to irrigated cropland. None of these projects are included under the Instream Alternative.

MADISON RIVER DRAINAGE

Table 6-29 lists five historical and archaeological sites affected in the Madison drainage by project GA-201 under the Consumptive Use and Combination alternatives. Known sites are located on land managed by BLM, DFWP, or private landowners. Several sites are on DFWP land used for public access to the Madison River. Most potential impacts could be avoided by locating the proposed diversion and pipeline off the sites. No sites have been recorded in the 5,900 acres of cultivated land in project GA-201. New sites might be found in the 2,000 acres of pastureland that is to be converted to irrigation.

Significant fossil-bearing formations rise above ground surface to the north and south of the project.

The Instream Alternative would not include project GA-201, resulting in no impacts.

Jefferson and Boulder Drainages

Known archaeological or historical sites could be affected under the Consumptive Use Alternative by three irrigation projects in the Jefferson drainage (Table 6-30). Projects BR-101, JV-201, and JV-203 include parcels of state-owned land that may require evaluation under the Montana Antiquities Act. In particular, BR-101, which would be developed under either the Consumptive Use or Combination alternatives, proposes to irrigate public and private land included in the Three Forks of the Missouri National Historic Landmark. Adjustment of proposed project boundaries to avoid this site would minimize the potential for effects. Projects JV-80, JV-81, and JV-202, are located in townships known to contain significant fossil bearing formations exposed at the surface.

No archaeological, historical, or paleontological sites are known to exist on the proposed irrigation projects in the Boulder River drainage.

Big Hole, Beaverhead, Ruby, and Red Rock River Drainages

No effects on known historical, archaeological, or paleontological sites are foreseeable in these drainages under any of the alternatives.

Missouri River Drainage - Three Forks to Holter Dam

The proposed reservations and irrigation projects along this segment are located on the benches and uplands above Canyon Ferry Reservoir, along the Missouri, and in the drainage of Deep Creek and Spring Creek, tributaries to the Missouri River. These landscapes have a high potential for containing prehistoric and historic resources which might provide valuable information on historical and prehistoric peoples. Known sites potentially affected by development of irrigation projects under the Consumptive Use Alternative are shown in Table 6-31. Several projects are proposed near areas where fossilized mammal teeth have been found. Construction of diversion facilities and pipelines for projects BR-28, BR-29, and BR-211 would directly disturb known fossil areas on BUREC land. Further study would be required to determine the significance of this disturbance.

Table 6-29. Summary of known historical and archaeological sites potentially affected by irrigation reservation (GA-201) on the Madison River drainage

Project number	Site number	Site Type	Location
GA-201	24GA0761	lithic scatter[a]	diversion/pipeline
	24GA0762	rock cairn, tipi rings, lithic scatter	pipeline
	24GA0634	lithic chipping station\lookout	pipeline
	24GA0757	lithic scatter	diversion
	24GA0759	historic dugout	diversion

a Lithic scatter may include rock chips produced during tool making, or finished tools such as arrowheads, spear points, or scrapers.

Source: Montana Historical Society 1988–1991 and University of Montana 1991

Table 6-30. Summary of known historical and archaeological sites potentially affected by irrigation reservations on the Jefferson River drainage

Project number	Site number	Site Type	Location
BR-101	24GA0212	Three Forks of the Missouri - National Historic Landmark	in field
	24GF0062	rock pile	in field
JV-201	24MA0717	historic Dry Boulder Creek bridge	borders field
JV-203	24JF0755	prehistoric occupation site	borders field

Source: Montana Historical Society 1988–1991 and University of Montana 1991

Table 6-31. Historical, archaeological, and paleontological sites within areas affected by the irrigation projects proposed by Broadwater and Lewis and Clark conservation districts

Project number	Site number	Site Type	Location
BR-11	24BW0256	lithic quarry	borders field
	24BW0292	Oligocene/ Miocene fossils	diversion/pipeline
BR-14	24BW0047	tipi rings	pipeline
	24BW0054	lithic scatter[a]	borders field
BR-28	24BW0202	Miocene fossils	diversion/pipeline
BR-108	24BW1043	tipi ring	borders field
BR-109	24BW0291	Oligocene fossils	pipeline
BR-110	24BW0033	lithic scatter	pipeline
BR-111	24BW0499	historic Broadwater/ Missouri Canal	pipeline
LCI-10	24LC1030	tipi ring/ occupation site	pipeline/field

a Lithic scatter may include rock chips produced during tool making, or finished tools such as arrowheads, spear points, or scrapers.

Source: Montana Historical Society 1988–1991 and University of Montana 1991

For the Instream and Combination alternatives, historical, archaeological, and paleontological impacts would be similar to those described under the Consumptive Use Alternative, except that BR-111 would not be developed and its impacts would not occur.

Missouri River Drainage - Holter Dam to Belt Creek

Irrigation projects are located on the floodplains and terraces above stream courses where there is potential for historical and archaeological resources.

Under the Consumptive Use Alternative, project C5-541 would affect site 24CA0285, a prehistoric campsite. Project CSI-35 could affect site 24CA0036, a lithic scatter. Project LC-11 is near two historic sites—24LC0757 and 24LC0758—but development of the project is not likely to affect these sites. DNRC field visits identified remnants of another historic site on private land in the vicinity of this proposed project diversion. The discovered site is believed to be a location where ice was made for use in the city of Helena prior to the use of electric-powered refrigerators. Additional field work would be required to determine the significance of this site and record any important information that could be lost through project development. No sites listed on the National Register of Historic Places or determined to be eligible for listing would be affected, nor would known paleontological sites.

Impacts of project CS-541 on cultural resources under the Instream and Combination alternatives would be similar to those under the Consumptive Use Alternative. The Instream Alternative would include LC-11 and have similar impacts. The Combination Alternative would include CS-35 and would have effects similar to those under the Consumptive Use Alternative. No other cultural resources would be affected under either the Instream or Combination alternatives.

Dearborn River Drainage

Under the Consumptive Use and Combination alternatives, project LCI-20 would be developed on private land on a bench above the floodplain of the Dearborn River. A number of archaeological sites were identified nearby, and site 24LC0632, an extensive tipi ring complex, is located within the area of proposed irrigation and would be destroyed. Further field work would be required to determine the extent of the site and the significance of information contained there. The proposed project would be developed on private land. Under the Instream Alternative, project LCI-20 would not be developed.

Smith River Drainage

The proposed projects would be developed along the floodplains and terraces of the Smith River and its tributaries. The area surrounding the confluence of the Smith and Missouri rivers was used extensively by historical and prehistoric people and is expected to yield significant information regarding them. There are a number of recorded historic and prehistoric sites in the area, though most sites would not be affected by the proposed irrigation under the Consumptive Use and Combination alternatives. Because of the past activities believed to have occurred in this area, new sites may be found. Table 6-32 lists the known sites that would be affected by the irrigation projects.

Project MEI-11 is located within a township having exposed geological formations known to produce fossils, but it is not known whether fossil-bearing formations are present at the surface in areas affected by the proposed project.

The Instream Alternative would exclude project CS-71 from the reservation process, avoiding impacts to site 24CA0070, a lithic scatter. Under the Instream Alternative, the potential for new site discovery exists where irrigation projects would develop pasture or rangeland.

SUN RIVER DRAINAGE

The proposed projects are located on the floodplains and terraces of the Sun River and its tributaries. These landscapes have high potential to contain sites with historical and prehistorical information about past use of the area. Much of the area, is privately owned and has not received a detailed cultural resource survey. Projects proposed under the Consumptive Use or Combination alternatives that would affect known sites are indicated in Table 6-33.

Four projects in this drainage are near locations known to produce fossils. The Kootenai Formation has produced fossilized plants in outcrops near Belt Creek. Projects CSI-92 and CSI-200 are located within the township where this formation is known to outcrop. The Blackleaf Formation is known to produce invertebrate fossils. Projects TEI-90 and TEI-100 are located within the township where this formation is exposed.

Under the Instream Alternative, only one project would affect a known archaeological site. Project CSI-92 would affect site 24CA0074, a prehistoric occupation site. Like other development alternatives, irrigation projects proposed on pasture or rangeland may result in discovery of new archaeological sites. As with other alternatives, projects CSI-92 and CSI-200 would be developed in townships where the Kootenai Formation is found at the surface.

BELT CREEK DRAINAGE

No known historical, archaeological, or paleontological resources would be affected by the development of reservations under the Consumptive Use, Instream, or Combination alternatives in this drainage.

MARIAS RIVER DRAINAGE

While the landscapes surrounding the Marias River and its tributaries have potential to contain historical and archaeological remains, few known sites would be affected by development of the proposed projects. Table 6-34, Marias River, lists the irrigation projects under the Consumptive Use that might affect known resources. Project LI-261, included in the Consumptive Use and Combination alternatives, is located near several sites but would not directly affect most of them if field boundaries are

Table 6-32. Archaeological sites potentially affected by the irrigation projects proposed in the Smith River drainage

Project number	Site number	Site Type	Location
CS-61	24CA0023	buffalo jump	field overlaps
CSI-102	24CA0285	lithic scatter	field overlaps
CS-331	24CA0016	buffalo jump	nearby field
CS-71	24CA0070	lithic scatter	nearby field
CSI-120	24CA0040	buffalo jump	at edge of field

Source: Montana Historical Society 1988–1991 and University of Montana 1991

Table 6-33. Historical and archaeological sites potentially affected by projects in the Sun River drainage

Project number	Site number	Site Type	Location
CSI-92	24CA0074	prehistoric occupation site	overlaps field
CS-471	24CA0241	historic wooden bridge	edge of field
	24CA0243	historic wooden bridge	edge of field
TEI-100	24LC0177	rock alignment/ tipi ring/hearth	edge of field

Source: Montana Historical Society 1988–1991 and University of Montana 1991

located with sites in mind. Project BSS-2, included only in the Consumptive Use Alternative, would irrigate a large but disturbed lithic scatter site in a cultivated field. Project TO-221 and its impacts would occur under all alternatives.

Teton River Drainage

Projects proposed in this drainage are located on the floodplains and terraces above the Teton River and its tributaries. While these landscapes have potential to contain historical and archaeological artifacts, a data search indicates most are located outside the boundaries of the proposed developments. Under the Consumptive Use Alternative, construction of the proposed pipeline for project TEI-70 could affect site 24TT0039, a series of tipi rings. A field examination of the proposed route would be required to minimize the potential for impacts at this site. No known sites would be affected under either the Instream or Combination alternatives.

Missouri River drainage - Belt Creek to Fort Peck Reservoir

The proposed projects in this subbasin are located on the floodplains and terraces of the Missouri River and tributary streams, and Big Sag, Shonkin, Highwood, and Cut Bank creeks. Few of the proposed projects would affect known sites. No sites listed on the National Register of Historic Places or determined eligible for listing would be affected by the proposed projects. The sites potentially affected under the Consumptive Use Alternative are listed in Table 6-35, Middle Missouri Subbasin. Known site density is high in the area about 1 mile upstream from the confluence of the Missouri and Judith rivers, the area of project FEI-10. One site, Old Fort Claggett, is listed on the Register of Historic Places, and is within 1/2 mile of the proposed project. While no direct impacts to this site are expected, other associated sites located next to or within boundaries of the proposed project may be affected. Additional fieldwork would be required to determine the degree of encroachment upon boundaries of known sites. Given the density of known sites and use of this area in the past, new sites could be discovered.

The Instream Alternative includes projects FEI-10, CHI-21, CH-21, CH-22, and CHI-40, and these would have the same effects as they would have under the Consumptive Use Alternative. The Combination Alternative would affect the same sites as the Consumptive Use Alternative with the exception of CHS-6 which would not be developed.

Table 6-34. Historical and archaeological sites potentially affected by irrigation reservations in the Marias River drainage

Project number	Site number	Site Type	Location
LI-261	24LT0027	cairns	in field
	24LT0029	cairns	near pipeline route
	24LT0030	cairns	borders field
	24LT0032	hearth/roast pit	borders pipeline
	24LT0033	cairns	borders field
	24LT0034	cairns	edge of field
TO-221	24TL0077	tipi ring/cairn/ lithic scatter	unknown
BS-31	24CH0381	lithic scatter	unknown
BSS-2	24CH0458	lithic scatter	in field

Source: Montana Historical Society 1988–1991 and University of Montana 1991

Judith River Drainage

Project land lies on the plains and terraces of the Judith River and its tributaries. A search of known sites indicates that the proposed projects would not affect historical or archaeological resources. All alternatives include projects FE-671, FE-672, and FE-673. These projects would be developed adjacent to site 24FR0411, which records the location of the Chicago and Milwaukee Railroad. Much of the railroad as it passes by the proposed irrigation projects has been rebuilt and is now used by the Burlington Northern Railroad. No effects would occur as a result of development of the projects as proposed.

Musselshell River Drainage

Project LM-20 would not affect any cultural sites on file with SHPO. The abandoned coal mines serving as the water source for this project may have some historic significance but have not been formally evaluated. Land to be irrigated has not been identified so any historical or archaeological sites affected are not known. Project LM-20 would not be developed under the Combination and Instream alternatives.

Table 6-35. Historical and archaeological sites potentially affected by proposed irrigation projects in the Middle Missouri Subbasin[a]

Project number	Site number	Site Type	Location
FEI-10	24FR0202	lithic scatter	nearby
	24FR0204	historic Camp Cook	nearby
	24FR0206	possible burial site	borders field
	24FR0207	possible burial site	borders field
	24FR0208	campsite	borders field
	24FR0211	historic wooden irrigation pipe	in field
	24FR0214	trading post/midden	at diversion
FEI-30	24FR0201	tipi ring	in field
CH-21	24CH0179	prehistoric campsite	overlaps field
CH-211	24CH0292	historical travel route	unknown
CH-511	24CH0284	lithic workshop	unknown
CHI-22	24CH0484	historic Churchill homestead	overlaps field
CHI-40	24CH0215	cairn/tipi ring/ hearth	nearby
	24CH0343	lithic scatter/ white site	borders field
CHS-6	24CH0181	prehistoric lithic workshop	near diversion
	24CH0182	prehistoric camp	at diversion
	24CH0210	kill site/ rock alignment	borders pipeline
	24CH0585	Great Northern Railroad/ station houses	borders field

a Table does not include sites affected by the Bureau of Reclamation's proposed Virgelle reservation.

Source: Montana Historical Society 1988–1991 and University of Montana 1991

Fort Peck Reservoir and Small Tributaries

Project VAS-1 would irrigate the uplands between Milk River, Fort Peck Reservoir, and the Missouri River under all three alternatives. Much of this land (23,000 acres) is under cultivation. A search of records maintained by the State Historic Preservation Office indicates the project would affect only known sites listed in Table 6-36. Additional fieldwork would be required to determine the effects development would have on these sites.

Portions of the project would disturb pasture or rangeland which could lead to discovery of new sites. The area has not received an intensive survey to discover such resources. Other sites, such as the original townsite of old Fort Peck, used during construction of Fort Peck Dam, are known to be present nearby but should not be affected by the project.

The proposed diversion structure would be located on federal land and portions of the irrigation projects would include state owned parcels. Activities to develop portions of the project on federal or state land may require additional cultural resource survey prior to project development.

The badlands surrounding Fort Peck Reservoir are known to produce various fossils including complete dinosaur skeletons. The diversion, pipeline, and canal routes proposed as part of project VAS-1 would cross geologic formations similar to those which have produced fossils in other areas. Discovery of additional fossils could further understanding of the prehistoric past if the information were collected.

Table 6-36. Known historical and archaeological resources potentially affected by the Valley Conservation District projects

Project number	Site number	Site Type	Location
VAS-1	24VL0027	rock cairns/tipi ring	
	24FR0570	white site	
	24FR0571	white site	
	24FR1194	historic irrigation/conservatio	

Source: Montana Historical Society 1988–1991 and University of Montana 1991

RECREATION

General Impacts and Considerations

Reservations for consumptive use could adversely affect recreation by lowering flows and reservoir levels and decreasing boating, floating, fishing, and shoreline activity. Participation in these activities and the number of visits to streams are generally proportional to streamflow. Lower flows could create or worsen marginal boating and floating conditions, making passage difficult or impossible on some streams. Recreation settings also would be affected where streamflows decrease to zero or near zero. As the quantity and quality of recreational opportunities decrease, recreationists would use other rivers and reservoirs as they did when drought reduced streamflows in 1988 (Duffield et al. 1990). Crowded conditions and increased fishing pressure could occur on rivers used as substitutes because they have adequate streamflow (Economic Consultants Northwest 1991a).

Angler participation in fishing can be affected by several factors. Numerous studies indicate that fishing can provide psychological and social benefits besides the opportunity to catch fish (Driver and Knopf 1976; Driver and Cooksey 1977; Moeller and Engleken 1972). Primary reasons for trout fishing include being outdoors, getting away from it all, and enjoying scenery (Allen 1988). Other reasons include the opportunity to catch wild trout and test fishing skills.

Convenient access is another factor affecting participation in recreation. In Hagmann's (1979) recreation use study of the upper Clark Fork drainage, fishing and recreating close to home were two important reasons Montana residents gave for visiting streams in this drainage. Allen's study (1988) of 19 Montana rivers indicated that the desire to fish close to home was important in choosing a fishing location.

Lastly, anglers want to catch fish. Fishing pressure tends to be higher on streams with good water quality and abundant fish populations. Aquatic habitat and streamflow influence fish abundance. Therefore, angler use can be affected by the adequacy of aquatic habitat and streamflows.

Flows on certain streams will decline incrementally over the reservation development period as individual projects are constructed and more reservation water is used. The severity of effects would vary with flow rates and with the amount, timing, and location of diversions and return flows. Effects of additional depletions would be most severe on reaches of rivers and streams that already have low flows.

Instream flow reservations would help protect existing recreation opportunities on streams but may not fully preserve them. The current level of recreation activities probably would continue if no additional water is withdrawn. Even without additional withdrawals, dry years with low summer flows and dry reaches on some rivers would continue to occur.

Construction of new or upgraded diversion structures, powerlines, pipelines, or canals for some irrigation projects might cause short-term effects such as noise and dust. Pipeline construction crossing steep terrain or erodible soils near rivers and streams could increase water turbidity which might detract from the recreation setting. Pipeline trenching adjacent to recreation sites could create a short-term nuisance for some recreationists. The magnitude of these short-term construction impacts could be determined after project designs are complete and mitigation measures identified. Table 6-37 indicates the projects where short-term construction impacts could occur under each alternative.

Table 6-37. Projects where construction could cause short-term impacts to recreation

Stream or Reservoir	Project	Alternative: Consumptive Use	Alternative: Instream	Alternative: Combination
Sourdough Creek	Bozeman Municipal	X	X	X
Madison River	GA-201	X	—	X
Canyon Ferry Reservoir	BR-104	X	—	—
Sun River	CSS-200	X	—	—
Marias River	BSS-2	X	—	—
Missouri River	CHS-3	X	—	X
	CHS-5	X	—	X
	CHS-6	X	—	—
	BUREC	X	X	X
Judith River	FEI-50	X	—	—
Fort Peck Reservoir	VAS-1	X	X	X

For larger projects, construction crews could cause short-term impacts when they use recreation areas for temporary housing locations. These impacts would vary with: size of the construction crew, whether crew members are local or nonlocal, timing of construction, and number of recreation sites and their use level in the surrounding area. Impacts could include displacement of current recreationists who use these sites. This effect would be most severe on weekends and holidays at sites currently near or at capacity. Consultation between project developers and the appropriate federal, state, or local recreation managers and implementation of their suggestions would help mitigate this impact. Enforcement of current stay limits at recreation sites also would help mitigate this impact.

Except as noted, municipal water reservations would have a negligible effect on instream flows and water-based recreation in their source streams. Similarly, instream reservations would not reduce flows below present levels and would help maintain existing opportunities for recreation.

Impacts of the Consumptive Use, Instream, and Combination Alternatives

Gallatin Drainage

Under the Consumptive Use and Combination alternatives, additional water withdrawals would cause further decline in water-based recreation on the Gallatin River, which already has diminished levels of such recreation due to low flows in dry years. Water-based recreation also would decline under the Combination Alternative but to a lesser extent than under the Consumptive Use Alternative. The Instream Alternative would have negligible effects on recreation in the Gallatin River drainage. Adverse effects of the Consumptive Use and Combination alternatives would be limited to the segment of the Gallatin River below the canyon.

Water-based recreation might decline on the East Gallatin River under the Consumptive Use and Combination alternatives, but the extent of this impact is not known.

Bozeman's municipal reservation would affect recreation on Sourdough Creek under all three alternatives, and impacts would depend on reservoir operation and release patterns. These variables are not clearly defined in the application. The potential for dispersed recreation at the proposed reservoir site cannot be predicted until project design is complete.

Madison Drainage

Under the Consumptive Use and Combination alternatives, project GA-201 would reduce flows in the Madison River, making boating and floating more difficult by decreasing stream depth over gravel bars below the Greycliff fishing access area. Continued use of the Madison as a substitute when other rivers experience low flows, due to use of reserved water, could lead to crowding and increased fishing pressure under the Consumptive Use and Combination alternatives and to a much lower extent under the Instream Alternative.

Jefferson and Boulder Drainages

At present, flows in the Jefferson River near the Waterloo Bridge nearly cease in dry years, and additional withdrawals for irrigation under the Consumptive Use Alternative would worsen this problem. Flows also would be reduced between 50 and 100 percent on a 0.8-mile segment of the Jefferson River next to Headwaters State Park, adversely affecting fishing and floating. Effects would be somewhat less under the Combination Alternative than under the Consumptive Use Alternative because less water would be withdrawn from the river. Effects would not occur under the Instream Alternative. Under the Consumptive Use Alternative, upgraded diversion structures for projects JV-202 and JV-204 could create obstacles or hazards for boaters and floaters, but the extent of this effect would remain unknown until project designs are complete.

Under the Consumptive and Combination alternatives, reduced flows would adversely affect recreation on the Boulder River between the town of Boulder and Cold Spring, where low flows already occur. Effects would be the same under both of these alternatives but would not occur under the Instream Alternative.

Big Hole, Beaverhead, Ruby, and Red Rock Drainages

The municipal reservation requested by the City of Dillon is the only consumptive use application in these drainages. This reservation on the Beaverhead River would have negligible effects on recreation.

Missouri River Drainage - Three Forks to Belt Creek

While recreational use of the Missouri River main channel between Three Forks and Belt Creek would not be substantially affected under any alternatives,

usability of some side channels for boating and floating could decrease in dry years. Continued use of the Missouri as a substitute when other rivers experience low flows could lead to crowding and increased fishing pressure under the Consumptive Use and Combination alternatives and to a much lesser extent under the Instream Alternative. These conditions could lower trip quality for some recreationists.

Under the Consumptive Use, Instream, and Combination alternatives, recreation could be affected on Warm Springs Creek and Prickly Pear Creek as shown in Table 6-38.

CANYON FERRY RESERVOIR

Under the Consumptive Use and Combination alternatives, water levels in Canyon Ferry Reservoir would drop to critical levels during late summer and fall in the driest 1 year in 10. Most public boat ramps would be unusable in August and September in very dry years. Exposed rocks and sandbars would create hazards for motorboats and waterskiers during very dry years when surface elevations would fall below 3,792 feet. An elevation of 3,795 feet is considered optimum during the summer period (May 21 to September 31) (DFWP 1989a). Under the Consumptive Use Alternative in the driest 1 year in 10, reservoir

Table 6-38. Tributaries where recreation might be affected by water reservations

Stream	Project	Alternative: Consumptive	Alternative: Instream	Alternative: Combination	Remarks
Missouri River Drainage - (Three Forks to Belt Creek)					
Warm Springs Creek	BR-40	X	X	X	Fishing might decrease on Warm Springs Creek. This tributary to the Missouri River has low fishing use.
	BR-41	X	X	X	
	BR-42	X	X	X	
	BR-44	X	X	X	
Prickly Pear Creek	Helena Municipal	X	X	X	Recreation use might decrease if the aquifer proposed as a water source is connected to the creek.
Marias River Drainage -					
Two Medicine River	PO-421	X	—[a]	X	Recreation use and activities are poorly documented on stream reaches on the Blackfeet Indian Reservation. Impacts are unknown.
	POI-10	X	—	X	
Birch Creek	PO-171	X	—	X	
	PO-251	X	—	X	
Whitetail Creek	GL-201	X	—	X	
Cut Bank Creek	GL-11	X	X	X	
	GL-221	X	X	X	
Teton River Drainage -					
Teton River/Spring Creek	TE-321	X	X	X	The streamside setting and fishing that occurs in Choteau City Park and adjacent stream reaches would be affected if flows in Spring Creek are reduced substantially.
Judith River Drainage -					
Louse Creek	JB-21	X	—	X	Recreation use and activities are poorly documented on these tributaries. Uses could be affected by irrigation withdrawals.
	JB-231	X	X	X	
	JB-232	X	X	X	
Running Wolf Creek	JBS-3	X	X	X	
	JB-261	X	—	X	
Wolf Creek	FE-81	X	—	—	
Little Casino Creek	FE-431	X	X	X	
Olsen Creek	FE-671	X	X	X	
Little Trout Creek	JB-309	X	—	—	
McCarthy Creek	JB-111	X	—	X	

[a] Blank space indicates a project is not included under that alternative.

levels would drop by 4 to 6 feet below current levels during the summer and fall. This compares to 1 to 2 feet under the Combination Alternative and 1 foot or less under the Instream Alternative (Appendix C). Access to the reservoir from private docks also could be difficult unless they have been designed for low water conditions. Effects of low reservoir levels would continue through the summer and fall until water-based recreation ends for the year. Effects would be more severe when consecutive dry years make it impossible to fill the reservoir.

Access to the reservoir would be more difficult during the winter. Reservoir elevations during the winter of dry years would fall farther below the optimum 3,786 feet: 1 to 4 feet under the Consumptive Use Alternative, 1 to 2 feet under the Combination Alternative, and 1 foot under the Instream Alternative.

Smith River Drainage

Most floating on the Smith River occurs in the canyon above Hound Creek. Under the Consumptive Use Alternative, irrigation withdrawals on the Smith River would further shorten the floating season on this reach. Under the Instream and Combination alternatives, water-based recreation through the Smith River Canyon would not be affected. Water-based recreation on the Smith River below Hound Creek might decline under all three alternatives, but the extent of this impact is not known. Project CSI-102 overlaps land owned by DFWP in all alternatives. Boundaries for this proposed project would have to be shifted to avoid conflict with recreation use or site improvements.

Dearborn River Drainage

Under the Consumptive Use and Combination alternatives, impacts to recreation on the Dearborn River would be minor. The summer low-flow conditions and short floating season that currently occur on the Dearborn would be slightly worsened. These impacts would not occur under the Instream Alternative.

Sun River Drainage

Under the Consumptive Use Alternative, conditions for water-based recreation on the Sun River below Simms would worsen during the summer of dry years, and flows near Vaughn would be zero during July of very dry years. Conditions also would worsen under the Combination and Instream alternatives, though the magnitude of effects would be less than under the Consumptive Use Alternative.

Belt Creek Drainage

Under all three alternatives, flows and recreation would decline on segments of Belt Creek that currently have low flows. The magnitude of effects would be greatest under the Consumptive Use Alternative, less under the Combination Alternative, and least under the Instream Alternative.

Marias River Drainage

Under the Consumptive Use and Combination alternatives, additional water withdrawals would cause further decline in water-based recreation on the Marias River above Tiber Reservoir. Low flows on this river already have diminished use in some years. Effects would be less severe under the Combination Alternative due to smaller water withdrawals and would be minimal under the Instream Alternative.

None of the alternatives would affect existing recreation opportunities at Tiber Reservoir.

Under the Consumptive Use Alternative, water-based recreation on the Marias River below project BSS-2 would decline in dry years, with effects most severe in July of the driest 1 year in 10 when flows near Loma would reach zero. Under the Combination Alternative, flows in the Marias near Loma would decrease from 234 and 228 cfs to 194 and 172 cfs during June and July in the driest 1 year in 10. The degree to which reducing flows to these levels would limit recreation opportunities is unknown. Impacts to recreation would be minimal under the Instream Alternative.

Table 6-38 indicates projects under each alternative that might affect recreation on Two Medicine River, and Birch, Whitetail, and Cut Bank creeks. The type and amount of current recreational use is not well documented for other tributaries with proposed irrigation projects in this drainage.

Teton River Drainage

Low or zero flows and limited recreation activities are common on the lower Teton through the summer and fall of dry and normal years. The Consumptive Use Alternative would extend this condition to August and September of wet years. Under the Instream and Combination alternatives, existing low flow conditions would worsen slightly.

Local benefits to recreation could result from storage projects TE-581 and CH-641 for fish and game purposes on Gamble and Alkali coulees (Table 6-21).

Project TEI-50, included only in the Consumptive Use Alternative, would conflict with the Eureka Reservoir fishing access site where a proposed center pivot overlaps the recreation site. The project might be redesigned to avoid this conflict. The streamside setting and fishing that occurs in Choteau City Park and adjacent stream reaches would be adversely affected if project TE-321 reduces flows substantially in Spring Creek (Table 6-38).

Missouri River Drainage - Belt Creek to Fort Peck Reservoir

BLM has recommended flows on the wild and scenic Missouri for boating and floating as shown in Table 6-39. All alternatives would further decrease flows below these recommendations (Table 6-39). Flow reductions would be greatest under the Consumptive Use Alternative and least under the Instream Alternative.

The pumping plant for the proposed Virgelle project could create a noise and visual intrusion for recreationists using the wild and scenic Missouri. The extent of these and other potential effects cannot be determined until project plans are complete.

Local benefits to recreation could result from project CH-181 under all alternatives (Table 6-21), a storage project for fish and game purposes on Cut Bank Coulee.

Table 6-39. Changes in flow affecting boating and floating in the Missouri River between Fort Benton and Fred Robinson Bridge under the Consumptive Use, Instream, and Combination alternatives

Missouri River at:	Recommended flows (cfs) for watercraft use during certain periods[a]			Month	Percent of time flow is equaled or exceeded[b]			
	Watercraft Type	Period	Flow		Existing condition	Consumptive Use Alternative	Instream Alternative	Combination Alternative
Fort Benton	Motorboats < 50 hp	May 15-July 15	6,390	May	90	90	90	90
				June	83	81	83	82
				July	46	41	45	42
	Rafts/innertubes/ canoes/kayaks	July 15-November 15	4,480	July	65	59	64	62
				August	48	39	48	45
				September	51	42	48	46
				October	81	79	81	81
				November	83	82	83	82
Virgelle	Motorboats < 50 hp	May 15-July 15	7,470	May	90	90	90	90
				June	83	81	83	83
				July	49	39	46	45
	Rafts/innertubes/ canoes/kayaks	July 15-November 15	5,150	July	69	62	68	67
				August	54	37	53	50
				September	51	42	48	46
				October	82	78	82	81
				November	88	85	88	87
Landusky (Cow Island)	Motorboats < 50 hp	May 15-July 15	8,300	May	89	89	89	89
				June	82	80	81	81
				July	50	43	46	46
	Rafts/innertubes/ canoes/kayaks	July 15-November 15	5,600	July	72	64	72	71
				August	60	40	60	46
				September	51	45	50	46
				October	81	78	81	80
				November	89	87	88	87

[a] Source: U.S. Bureau of Land Management 1984
[b] Estimated flows based on DNRC computer modeling results.

Judith River Drainage

Under the Consumptive Use Alternative, flow reductions in the Judith River could adversely affect water-based recreation. Effects would be less under the Combination Alternative and least under the Instream Alternative. Project JBI-2, which is included only in the Consumptive Use Alternative, would withdraw water from the reach of the Judith River above Big Spring Creek where flows are currently low (Gardiner 1989). Effects would be most adverse during August when flows would be reduced by half during the driest 2 years in 10. However, these effects might be lower due to releases from Ackley Lake. Two other irrigation projects that are included only under the Consumptive Use Alternative—FEI-50 and FE-41—would withdraw water from a reach of the Judith that is fed by Big Spring Creek and Warm Springs Creek. Long-term effects of withdrawals for these two projects are unknown.

Irrigation withdrawals that could affect recreation on tributaries with low or unknown use for fishing or other activities are shown in Table 6-38.

Musselshell River Drainage

Recreation on the Musselshell River could be affected by project LM-20, but these effects cannot be specified until streamflow reductions along the river are quantified. Project LM-20 is included only under the Consumptive Use Alternative.

Fort Peck Drainage and Small Tributaries

Under the Consumptive Use and Combination alternatives, decreases in reservoir elevation should have minor effects on recreation opportunities at Fort Peck Reservoir. Summer elevation losses of 1 foot under the Consumptive Use and Combination alternatives would make access to the water more difficult when low reservoir levels occur. Access to the reservoir could become more difficult or impossible when consecutive dry years limit reservoir refilling. Management by the Army Corps of Engineers also would affect reservoir levels and could either mitigate or intensify effects of lowered water levels. Reservoir elevations would be changed less than 1 foot under the Instream Alternative, and effects on recreation would be minor.

Changes in Recreational Use and Value Due to Decreasing Flows

Results of DNRC's 1989 recreational survey indicate that both number and quality of trips to Missouri basin streams decline with low streamflows. To assess how the value of water-based recreation would change with decreasing flows, the estimated values (marginal values) for an acre-foot of water that were derived from the DNRC recreation survey (Table 6-40) were combined with estimated streamflow changes (Table 6-41). The middle Missouri and Marias/Teton subbasins were combined for this analysis. The values in Table 6-42 are averaged over all rivers and streams within a subbasin.

The values per acre-foot were multiplied by the total change in average flows for each subbasin shown in Table 6-41. Table 6-42 shows the resulting changes in the value of recreation.

Table 6-40. Recreational values of an acre-foot of flow on rivers and streams

Subbasin	July/August	Rest of Year
Headwaters	$35.40	$8.23
Upper Missouri	$19.46	$4.76
Middle Missouri and Marias/Teton	$ 5.81	$1.63

Source: Duffield et al. 1990

Table 6-41. Average flow reductions (acre-feet) from different alternatives

Alternative	Flow reductions during July and August	Flow reductions during the rest of year
Consumptive Use		
Headwaters Subbasin	38,850.9	11,189.1
Upper Missouri Subbasin	20,163.1	51,193.6
Marias/Teton Subbasin	29,691.5	16,210.5
Middle Missouri Subbasin	125,897.0	89,993.0
Instream		
Headwaters Subbasin	0.0	121.0
Upper Missouri Subbasin	7,991.5	7,755.0
Marias/Teton Subbasin	2,397.5	1,554.7
Middle Missouri Subbasin	13,462.6	10,504.0
Combination		
Headwaters Subbasin	18,933.7	5,123.6
Upper Missouri Subbasin	20,470.5	20,743.2
Marias/Teton Subbasin	7,745.6	6,950.1
Middle Missouri Subbasin	51,084.1	35,983.0

Table 6-42. Reductions in annual value of recreation due to change in average flows

Alternative/ Subbasin	Flow reductions during July and August	Flow reductions during rest of year	Total
Consumptive Use			
Headwaters	$1,400,000	$92,000	$1,492,000
Upper Missouri	$390,000	$240,000	$630,000
Marias/Teton	$170,000	$26,000	$196,000
Middle Missouri	$730,000	$150,000	$880,000
Total			$3,198,000
Instream			
Headwaters	$0	$1,000	$1,000
Upper Missouri	$160,000	$37,000	$197,000
Marias/Teton	$14,000	$3,000	$17,000
Middle Missouri	$78,000	$17,000	$95,000
Total			$310,000
Combination			
Headwaters	$670,000	$42,000	$712, 000
Upper Missouri	$400,000	$99,000	$499,000
Marias/Teton	$45,000	$6,000	$51,000
Middle Missouri	$300,000	$59,000	$359,000
Total			$1,621,000

POWER PRODUCTION

GENERAL IMPACTS AND CONSIDERATIONS

Consumptive water uses can affect hydropower in two ways. First, to the extent they reduce flows through the hydroelectric generating facilities on the river they reduce the availability of hydroelectric power, the lowest cost power currently generated. This lost power must be replaced with new sources of electricity, generally at higher cost. Second, the use of electric power for proposed irrigation and municipal pumping also increases the need to acquire additional sources of power. Acquisition of new power sources will increase the cost of electricity to all consumers. The reason for this is that electricity is generally sold at rates based on the average cost of existing facilities. Where electricity from expensive new facilities is included, the average cost of power, and hence rates, must go up. Reservations for instream flow would not affect hydropower production.

IMPACTS TO HYDROPOWER GENERATION

Water is used over and over again on the Missouri to generate electricity. Ten dams on the Missouri River in Montana would be affected by the proposed reservations, 9 between Three Forks and Fort Benton, and Fort Peck Dam farther downstream (Map 4-12). Five hydroelectric dams produce power on the Missouri River in the Dakotas and Nebraska (Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point). Except in months so wet that water would flow over dams without generating electricity, water consumed for irrigation or municipal purposes results in reduced electric generation at all dams downstream. The impacts of water withdrawal on hydropower generation in Montana will depend upon the location of the withdrawal and how many dams lie downstream. However, DNRC estimates that any additional consumptive use in Montana's portion of the Missouri River basin will result in a loss totaling approximately 516 kWh per acre-foot at the five dams in the Dakotas and Nebraska.

The cost to electricity consumers and to society of reduced generation at Missouri River hydroelectric projects, in increased electric rates and environmental degradation, depends upon whether (and when) the lost power must be replaced with new power sources, and on the cost and impacts of the new power relative to the cost and impacts of the lost hydropower. If regional utilities have surplus capacity, it may not be necessary to regulate the lost power, but losses may take the form of a reduction in low-valued off-system sales or an increase in the cost of fuel and operation at other existing facilities. Power surpluses of the sort that might affect losses tend to be temporary, while the proposed irrigation and municipal water reservations would be for long-term projects.

The decade of surplus electric-generating capacity has now ended in Montana and the Pacific Northwest. The coming decade will be marked by a need for additional generating capacity. The power supply situation is expected to be similar in the rest of the Great Plains region. Hydropower lost as a result of increased irrigation and municipal withdrawals would increase the need to find additional power sources.

At present it is not possible to identify what resources might be chosen to replace the power lost due to irrigation and municipal diversions. However, it is likely that low-cost solutions such as conservation will be implemented first and will not be available to replace the additional water withdrawals. When conservation has reached its limits, new generating facilities will be necessary and the new power

probably will be more expensive than power from existing generating resources. The cost of replacement power might be comparable to the levelized cost of power from a new coal-fired generating plant, on the order of 50-100 mills/kWh (5 to 10 cents per kWh). (Levelized costs are averaged over the life of the generating facility.) Costs resulting from impacts to environmental quality and human health due to the development of coal-fired power plants are not included in the above amounts. These costs include labor for the construction and operation of the new generating facilities.

DNRC's estimates of lost hydropower production are based upon the operations of existing facilities on the Missouri River. As part of its application before FERC to relicense its Missouri River hydro projects, MPC has proposed to upgrade some of them by installing additional generating capacity and changing the mode of operation. A plan to add hydroelectric generation at Tiber Dam also is being considered. Hydropower losses under these future conditions might be greater than those estimated here.

Financial Impacts to Power Needs and Costs from Irrigation and Municipal Pumping Loads

Electricity is almost always sold at prices based on the average cost of generation from existing facilities. The cost of replacement power or power from new facilities is generally higher than that of existing facilities. Consequently, new electricity loads can impose costs, sometimes significant, on all other electricity consumers. DNRC's feasibility analysis for proposed irrigation projects assumed an average price of 40 mills/kWh (4 to 5 cents/kWh) for electricity to be used in pumping water to the projects. If the cost of replacement power averages 50 mills/kWh (5 cents/kWh), a new irrigation project requiring 100 MWh/year (100,000 kWh per year) would impose costs on other electric consumers amounting to \$1,000 per year. If the cost of replacement power averages 100 mills/kWh (10 cents/kWh), the costs to other users of electricity would amount to \$6,000 per year for this hypothetical project. Other electricity users subsidize the project to the extent they pay part of the costs of supplying it with power.

This subsidy would escalate dramatically for new irrigation projects, such as BUREC's proposed diversion at Virgelle, that propose to use low-cost power produced under the Pick-Sloan Act. As of 1983, Montana still is entitled to use 90 MW of Pick-Sloan power at a price of 2.5 mills/kWh (one-quarter cent/kWh) for pumping water to federal irrigation projects. According to the BUREC plan formulation working document (1988), Pick-Sloan power would be sold to the project at the 2.5 mills/kWh price. This is well below the 10.5 mills/kWh (1.05 cents/kWh) rate at which Pick-Sloan is currently sold to utilities. The diversion at Virgelle would use 16,890 Mwh per year to run pumps and canal-side pivot systems. The annual subsidy provided by electricity consumers to this project would be over \$800 thousand per year if the replacement cost were 50 mills/kWh (5 cents/kWh), or over \$1.6 million if the cost of replacement power were 100 mills/kWh (10 cents/kWh). Because federal irrigation projects are entitled to use cheap Pick-Sloan power, electrical cooperatives who now benefit from power produced under the Pick-Sloan Act would have their allocations reduced to provide power to the Virgelle project.

Impacts to Hydropower Generation and Costs from the Consumptive Use, Instream, and Combination Alternatives

DNRC estimated that depletions under the Consumptive Use Alternative would reduce generation at dams above Fort Peck an average 53 GWh (million kWh) per year. Generation at Fort Peck Dam would be reduced by another 29 GWh. Generation at the five lower Missouri dams would be reduced by 111 GWh.

If replacement power costs 50 mills/kWh (5 cents/kWh), the cost to utility ratepayers would average \$9.6 million per year. If replacement power costs 100 mills (10 cents/kWh), the annual cost to ratepayers would be \$19.3 million. In addition, society would have to bear additional environmental impacts associated with generating an additional 193 GWh. It would take around 62 MW of new coal fired generating capacity to produce this much energy.

DNRC estimated that the depletions under the Instream Alternative would reduce generation at dams above Fort Peck an average of 12 GWh per year. Generation at Fort Peck Dam would be reduced by 1 GWh, and the output of the five lower Missouri dams would be reduced by 12 GWh.

If replacement power costs 50 mills/kWh (5 cents/kWh), the cost to utility ratepayers would average \$1.2 million per year. If replacement power costs 100 mills/kWh (10 cents/kWh), the annual cost to ratepayers would be \$2.5 million. Society would have to bear the environmental impacts of approximately 11 MW of new generation.

DNRC estimated that the depletions under the Combination Alternative would reduce generation at dams above Fort Peck an average 24 GWh per year. Generation at Fort Peck Dam would be reduced by 11 GWh, and 44 GWh at the five lower Missouri dams.

If replacement power costs 50 mills/kWh (5 cents/kWh), the cost to utility ratepayers would average \$3.9 million per year. If replacement power costs 100 mills/kWh (10 cents/kWh), the annual cost to ratepayers would be \$7.9 million. Society would have to bear the environmental impacts of approximately 25 MW of new generation.

Irrigation and Municipal Power Use Impacts

Projects included in the Consumptive Use Alternative would use about 185 GWh per year. The costs that would be imposed on all other electricity consumers by the full development of all these projects would be \$1.8 million per year if the replacement cost were 50 mills/kWh (5 cents/kWh), or \$11.1 million if the replacement cost were 100 mills/kWh (10 cents/kWh).

Projects included in the Instream Flow alternative would use about 43 GWh per year. The costs that would be imposed on all other electricity consumers by the full development of all these projects would be \$0.4 million per year if the replacement cost were 50 mills/kWh (5 cents/kWh), or \$2.6 million if the replacement cost were 100 mills/kWh (10 cents/kWh).

Projects included in the Combination Alternative would use around 82 GWh per year. The costs that would be imposed on all other electricity consumers by the full development of all these projects would be \$0.8 million per year if the replacement cost were 50 mills/kWh (5 cents/kWh), or \$4.9 million if the replacement cost were 100 mills/kWh (10 cents/kWh).

Total Impacts to Ratepayers

Total electricity required in Montana under the Consumptive Use Alternative would be 267 GWh per year, about 2 percent of annual Montana electricity sales. The cost of replacing this power beyond the revenue received for irrigation pumping would be \$5.9 to \$19.3 million. For comparison, this amounts to approximately 1 to 4 percent of current sales of electricity in Montana.

The total impact to all ratepayers of full development under the Consumptive Use Alternative would be \$11.5 to \$30.4 million per year (Table 6-43). The present value of these impacts, assuming a 70-year

Table 6-43. Reductions in hydroelectric generation, increased power demands, and costs to ratepayers from projects in the Consumptive Use, Instream, and Combination alternatives

	Alternatives		
	Consumptive Use	Instream	Combination
Reduced hydroelectric generation (GWh)			
Above Fort Peck	53	13	24
Fort Peck	29	1	11
Dams in downstream states	111	12	44
Cost of reduced hydroelectric generation (millions of dollars per year)[a]	9.6 to 19.3	1.2 to 2.5	3.9 to 7.9
Increased power use (GWh/yr)	185	43	82
Cost to ratepayers (millions of dollars per year) from increased power use	1.8 to 11.1	0.4 to 2.6	0.8 to 4.9
Total costs to ratepayers from reduced hydroelectric generation and increased power use (millions of dollars per year)	11.5 to 30.4	1.7 to 5.1	4.8 to 12.8

[a] Range of costs is based on the cost of electricity generated at a new coal-fired power plant. Power from such a plant could cost 5 to 10 cents/kWh.

life for the irrigation projects and a 4.3 percent real discount rate, would be $253.4 to $669.8 million.

The total power losses in Montana under the Instream Alternative would be 56 GWh/year, about 1/2 percent of Montana's annual consumption (Table 6-43). The cost of replacing this power would be around $1 to $4 million. For comparison, this amounts to approximately 0.2 to 1.0 percent of current Montana sales of electricity.

The total impact to all ratepayers of full development under the Instream Alternative would be $1.7 to $5.1 million per year. The present value of these impacts, assuming a 70-year life for the irrigation projects and a 4.3 percent discount rate, would be $37.0 to $111.8 million.

Total power losses to Montana from the Combination Alternative would be 82 GWh per year, about 0.7 percent of annual Montana usage (Table 6-43). The cost of replacing this power would be $2.5 to $8.4 million. For comparison, this would be approximately 0.5 to 1.8 percent of current Montana sales of electricity.

The total impact to all ratepayers of full development under the Combination Alternative would be $4.8 to $12.8 million per year. The present value of these impacts, assuming a 70-year life for the irrigation projects and a 4.3 percent real discount rate, would be $105 to $282 million.

AGRICULTURAL ECONOMY

EMPLOYMENT, INCOME, AGRICULTURAL SALES, AND TAXATION

Development of the irrigation projects included in each alternative would cause farm-related employment to increase by 30 to 106 employees in the Missouri River Basin (Table 6-44). However, this increase would be offset by the decline in labor required to work, gradually decreasing amount of irrigated land in the basin. Farm income would increase by $1.7 to $6.1 million. Total employment and income would increase less than one-tenth of 1 percent (0.1 percent) in the basin.

Cash receipts from the sale of agricultural products would increase by a range of $8.1 to $32.4 million, or 1 percent to 4 percent across the basin (Table 6-44). The taxable valuation of Missouri River Basin counties and the tax receipts accruing to them would increase less than one-tenth of 1 percent (0.1 percent).

IMPACTS OF THE CONSUMPTIVE USE, INSTREAM, AND COMBINATION ALTERNATIVES

Tables 6-44 through 6-48 describe the effects of the alternatives on agricultural employment, personal income, agricultural sales, taxable valuation, and tax receipts in each of the subbasins. Under the Consumptive Use Alternative the Marias/Teton Subbasin would experience the largest agricultural employment increase (about 46 jobs), while the Middle Missouri Subbasin would have the largest increases in agricultural employment (20 jobs) under the Instream and Combination alternatives (Tables 6-46 to 6-48). Under the Consumptive Use and Combination alternatives, the Headwaters Subbasin would experience the greatest increased farm income related to sales of potatoes. However, increases in farm employment, income, and taxable valuation are minor and would amount to less than 1 percent in any of the subbasins.

Under the Consumptive Use Alternative, the Marias/Teton Subbasin would experience the greatest increase in agricultural sales, a $12.8 million (4.6

Table 6-44. Economic benefits to agriculture—Missouri River Basin

Category	1987 Actual[a]	Increase[a]	Percent Increase[b]
Consumptive Use Alternative			
Jobs	175,195	106	<0.1%
Total Personal Income	$4,285,266,000	$6,067,000	0.1%
Agriculture Sales	$ 787,781,000	$32,449,000	4.0%
Taxable Valuation	$ 665,347,000	$ 653,000	<0.1%
Tax Receipts	$ 161,761,875	$ 158,440	<0.1%
Instream Alternative			
Jobs	175,195	30.0	<0.1%
Total Personal Income	$4,285,266,000	$ 1,750,000	<0.1%
Agriculture Sales	$ 787,781,000	$ 8,146,000	1.0%
Taxable Valuation	$ 665,347,000	$ 253,000	<0.1%
Tax Receipts	$ 161,761,875	$ 60,000	<0.1%
Combination Alternative			
Jobs	175,195	53.0	<0.1%
Total Personal Income	$4,285,266,000	$ 5,059,000	0.1%
Agriculture Sales	$ 787,781,000	$18,761,000	2.3%
Taxable Valuation	$ 665,347,000	$ 372,000	<0.1%
Tax Receipts	$ 161,761,875	$ 90,000	<0.1%

a Dollars are reported to the nearest $1,000 and jobs are rounded to the nearest whole job.
b < 0.1% indicates the increase is less than one-tenth of one percent.

Source: Economic Consultants Northwest 1991b.

percent) increase if all projects were to be developed. The Middle Missouri Subbasin would experience the largest increase ($6 million or 2.6 percent) in agricultural sales under the Instream Alternative, while the Headwaters Subbasin would have the largest sales increase ($6 million or 3.7 percent) in the Combination Alternative (Tables 6-46 and 6-48).

SOCIAL AND ECONOMIC EFFECTS

POPULATION

Population is expected to grow by 16 percent in the Headwaters Subbasin, 12 percent in the Upper Missouri Subbasin, and 3 percent in the Middle Missouri Subbasin between 1990 and 2020 (Figure 6-22). Population in the Marias/Teton Subbasin is expected to remain fairly constant.None of this growth would be noticeably affected by water reservations.

Each municipal applicant developed population projections for its water service area based on available 1986 population information. In most cases, these projections assume that the city would grow at a rate greater than the surrounding county (Table 6-49).

DNRC reviewed these population projections using the 1990 census information. This information indicates that some city populations grew more slowly than expected or continued to lose population up to 1990. DNRC believes population projections for the following communities are too high: Bozeman, Chester, Conrad, Cut Bank, East Helena, Fort Benton, Great Falls, Lewistown, Shelby, Winifred and West Yellowstone.

SOCIAL EFFECTS

The development of additional irrigation projects and the establishment of some instream flow reservations would not noticeably change the character of Missouri River Basin communities. Towns such as Three Forks, Great Falls, and Fort Benton would still serve as local or regional agricultural trade and service centers. Outfitters and other recreation-related

Table 6-45. Economic benefits to agriculture—Headwaters Subbasin

Category	1987 Actual[a]	Increase[a]	Percent Increase[b]
Consumptive Use Alternative			
Jobs	52,807	16	<0.1%
Total Personal Income	$1,270,602,000	$3,480,000	0.3%
Agriculture Sales	$ 165,647,000	$8,060,000	4.9%
Taxable Valuation	$ 156,813,000	$ 137,000	<0.1%
Tax Receipts	$ 44,442,000	$ 35,000	<0.1%
Instream Alternative			
Jobs	52,807	0	<0.1%
Total Personal Income	$1,270,602,000	$ 0	<0.1%
Agriculture Sales	$ 165,647,000	$ 0	<0.1%
Taxable Valuation	$ 156,813,000	$ 0	<0.1%
Tax Receipts	$ 44,442,000	$ 0	<0.1%
Combination Alternative			
Jobs	52,807	7	<0.1%
Total Personal Income	$1,270,602,000	$2,503,000	0.2%
Agriculture Sales	$ 165,647,000	$6,148,000	3.7%
Taxable Valuation	$ 156,813,000	$ 57,000	<0.1%
Tax Receipts	$ 44,442,000	$ 16,000	<0.1%

a Dollars are reported to the nearest $1,000 and jobs are rounded to the nearest whole job.
b < 0.1% indicates the increase is less than one-tenth of one percent.

Source: Economic Consultants Northwest 1991b.

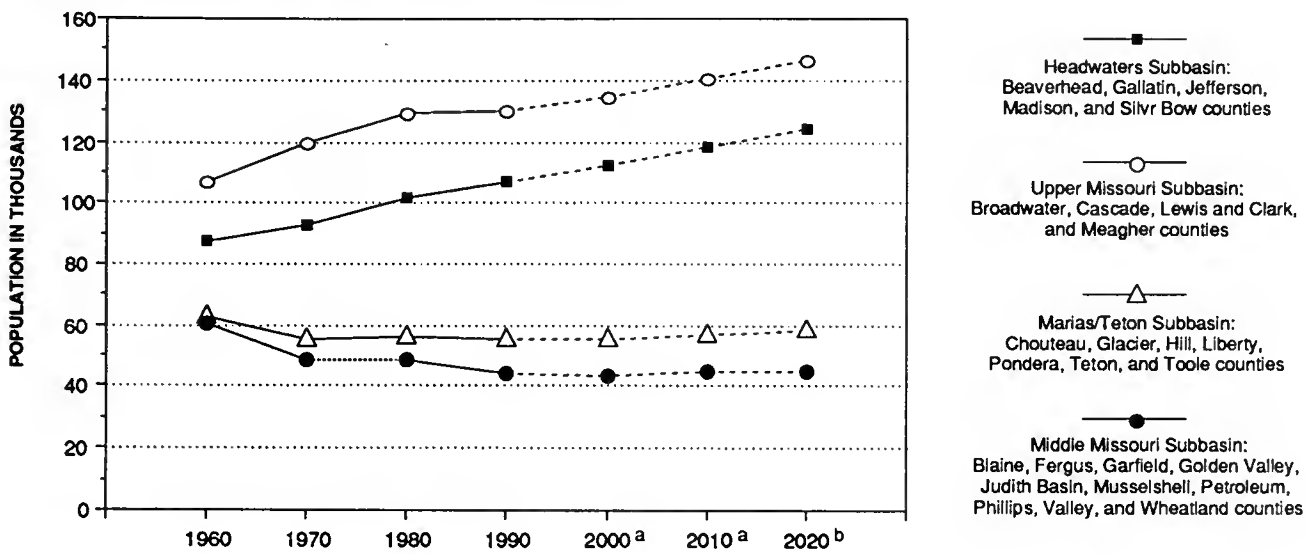
Table 6-46. Economic benefits to agriculture—Upper Missouri Subbasin

Category	1987 Actual[a]	Increase[a]	Percent Increase[b]
Consumptive Use Alternative			
Jobs	73,327	20	<0.1%
Total Personal Income	$1,761,056,000	$ 413,000	<0.1%
Agriculture Sales	$ 112,298,000	$4,447,000	4.0%
Taxable Valuation	$ 175,828,000	$ 164,000	<0.1%
Tax Receipts	$ 44,706,027	$ 37,000	<0.1%
Instream Alternative			
Jobs	73,327	7	<0.1%
Total Personal Income	$1,761,056,000	$ 349,000	<0.1%
Agriculture Sales	$ 112,298,000	$1,180,000	1.1%
Taxable Valuation	$ 175,828,000	$ 41,000	<0.0%
Tax Receipts	$ 44,706,027	$ 10,000	<0.0%
Combination Alternative			
Jobs	73,327	9	<0.1%
Total Personal Income	$1,761,056,000	$ 543,000	<0.1%
Agriculture Sales	$ 112,298,000	$1,867,000	1.7%
Taxable Valuation	$ 175,828,000	$ 71,000	<0.1%
Tax Receipts	$ 44,706,027	$ 16,000	<0.1%

a Dollars are reported to the nearest $1,000 and jobs are rounded to the nearest whole job.
b < 0.1% indicates the increase is less than one-tenth of one percent.

Source: Economic Consultants Northwest 1991b.

Figure 6-22. Missouri River basin population trends and projections



[a] Projected populations based on NPA Data, Inc.
[b] Projected populations based on NPA Data, Inc., as extended by DNRC

Table 6-47. Economic benefits to agriculture—Marias/Teton Subbasin

Category	1987 Actual[a]	Increase[a]	Percent Increase[b]
Consumptive Use Alternative			
Jobs	27,173	46	0.2%
Total Personal Income	$708,257,000	$ 1,026,000	0.1%
Agriculture Sales	$276,079,000	$12,818,000	4.6%
Taxable Valuation	$175,357,000	$ 105,000	0.0%
Tax Receipts	$ 39,746,000	$ 25,000	0.1%
Instream Alternative			
Jobs	27,173	3	<0.0%
Total Personal Income	$708,257,000	$ 340,000	<0.0%
Agriculture Sales	$276,079,000	$ 998,000	0.4%
Taxable Valuation	$175,357,000	$ 12,000	<0.0%
Tax Receipts	$ 39,746,000	$ 3,000	<0.0%
Combination Alternative			
Jobs	27,176	17	<0.1%
Total Personal Income	$708,257,000	$ 914,000	0.1%
Agriculture Sales	$276,079,000	$ 4,762,000	1.7%
Taxable Valuation	$175,357,000	$ 44,000	<0.0%
Tax Receipts	$ 39,746,000	$ 10,000	<0.0%

a Dollars are reported to the nearest $1,000 and jobs are rounded to the nearest whole job.
b < 0.1% indicates the increase is less than one-tenth of one percent.

Source: Economic Consultants Northwest 1991b.

Table 6-48. Economic benefits to agriculture—Middle Missouri Subbasin

Category	1987 Actual[a]	Increase[a]	Percent Increase[b]
Consumptive Use Alternative			
Jobs	21,888	25	<0.1%
Total Personal Income	$545,351,000	$1,148,000	0.2%
Agriculture Sales	$233,757,000	$7,124,000	3.0%
Taxable Valuation	$157,349,000	$ 248,000	0.2%
Tax Receipts	$ 32,867,000	$ 61,000	0.2%
Instream Alternative			
Jobs	21,888	20	<0.1%
Total Personal Income	$545,351,000	$1,062,000	0.2%
Agriculture Sales	$233,757,000	$5,968,000	2.6%
Taxable Valuation	$157,349,000	$ 199,000	0.1%
Tax Receipts	$ 32,867,000	$ 47,000	0.1%
Combination Alternative			
Jobs	21,888	20	<0.1%
Total Personal Income	$545,351,000	$1,100,000	0.2%
Agriculture Sales	$233,757,000	$5,984,000	2.6%
Taxable Valuation	$157,349,000	$ 200,000	0.1%
Tax Receipts	$ 32,867,000	$ 49,000	0.1%

a Dollars are reported to the nearest $1,000 and jobs are rounded to the nearest whole job.
b < 0.1% indicates the increase is less than one-tenth of one percent.

Source: Economic Consultants Northwest 1991b.

Table 6-49. Summary of population projections for municipalities requesting reservations

City	1990 Census population	Applicant projected population in 2025	Applicant compounded annual growth rate (1990-2025) (percent)	DNRC comments on applicant population projection
Belgrade	3,411	10,426	3.32%	Plausible
Bozeman	22,660	37,000	1.20%	Unlikely
Chester	942	1,418	.86%	Unlikely
Choteau	1,740	2,792	.98%	Plausible
Conrad	2,891	4,338	.77%	Unlikely
Cut Bank	3,329	6,069	1.10%	Unlikely
Dillon	3,991	5,000	.51%	Plausible
East Helena	1,538	2,938	1.30%	Unlikely
Fairfield	660	888	.70%	Plausible
Fort Benton	1,660	2,489	.86%	Unlikely
Great Falls	55,097	78,723	.70%	Unlikely
Helena	24,569	31,624	.50%	Plausible
Lewistown	6,051	9,618	.68%	Unlikely
Power	160	233	2.80%	Plausible
Shelby	2,763	4,387	.74%	Unlikely
Three Forks	1,203	1,860	.88%	Plausible
Winifred	150	187	.42%	Unlikely
West Yellowstone	913	2,246	2.00%	Unlikely

Source: U.S. Bureau of Census 1990

service providers would still constitute a growing segment of the local economic scene.

There are some social constraints to the development of large irrigation projects involving multiple landowners. Projects involving multiple landowners require them to jointly assume development responsibilities, necessitating substantial coordination and cooperation, but multi-party irrigation developments may be limited by the difficulty of achieving agreement on land use goals, financial liabilities, and a coordinated development schedule (DNRC 1990a). Projects are often delayed where long-term landowner goals differ or the future price of farm products is uncertain.

Another constraint to project development is local landowner opposition to installation of project facilities on their property. Major components of the 14 largest projects (Table 6-1) include pump stations, canals, and electric lines that would be located on land owned by other parties. Often, these other parties do not stand to profit or otherwise benefit from the proposed facilities, and may object to having them on their property.

COMMUNITY SERVICES

Little additional permanent employment would result from the development of irrigation projects. However, projects that require the construction of storage reservoirs, large pipelines, or extensive canals could require more labor than may be available locally. The in-migration of workers would place additional demand on community schools, medical, water supply, waste disposal facilities, and law enforcement agencies. Most construction projects would be completed in one field season, and these impacts would be limited to that time period. Projects larger than 2,500 acres or requiring large-scale construction require additional environmental analysis before construction begins.

NO ACTION ALTERNATIVE

If the Board does not grant any of the reservation applications, consumptive water users could still apply to appropriate water through the water use permitting process. If unappropriated water is not available, municipalities could still buy or condemn existing water rights. It is difficult to predict the amount of new irrigation that would occur through the permitting process in the basin. This amount would depend on economic conditions, the effect of water quality constraints, and the physical and legal availability of water. It has been suggested that the amount of new irrigation developed during this time could be offset by declines in existing irrigated acreage due to poor economic climate and changes in land use practices such as residential subdivisions.

Eventually the flows of the Missouri River may be divided among the basin states. This could be done by Congress, an agreement or compact between the states, or by the U.S. Supreme Court. In any case, if reservations are not granted for the municipal and irrigation projects, Montana's case for protecting water for these uses would not be as strong. According to Trelease (1982), the reservation process will provide a clear basis for Montana to protect water for future needs. The process provides this by carefully documenting points of diversion and place and type of use, by including only projects that are at least marginally feasible, and by requiring the reservants to be diligent in developing their reservations. These projects also could be protected to some extent by identifying them

in a state water planning document or inventorying them as future water development needs.

If no instream reservations are granted, instream flows in many streams would have no legal protection. In some instances, flows might be appropriated to the point where a stream becomes low or goes dry with resulting detrimental affects to aquatic life, wildlife, and recreation. On streams where low flows are already a problem (see Tables 4-2, 4-4, 4-6, and 4-8 Chapter 4), the situation could worsen. Electricity consumers could be subject to higher rates because of flow reductions caused by new consumptive use withdrawals, and water quality would deteriorate to the detriment of some water uses. However, Murphy rights might protect instream flows on some streams, although these rights could be reallocated if another use is determined to be of higher value. Existing hydropower rights and constraints posed by arsenic pollution have already limited new consumptive use development in the basin above Great Falls. However, the extent to which arsenic would continue to limit new development is unclear.

A benefit of granting reservations and completing the reservation process is that it provides a means for the state to divide water between competing intrastate users. The No Action Alternative could leave the state undecided as to how water should be allocated in the basin. This could harm Montana's ability to obtain its share of Missouri River water in an interstate water allocation proceeding.

If existing trends continue, few new storage projects will be built over the next 25 years. This is because of the existing environmental, financial, and economic constraints, and because storage projects have already been constructed at many of the best sites.

If the Board does not grant reservations, the water use permits issued after July, 1, 1985 (Appendix A) would not be subordinated to any of the reservations.

MEASURES THAT COULD BE ADOPTED TO REDUCE ADVERSE EFFECTS

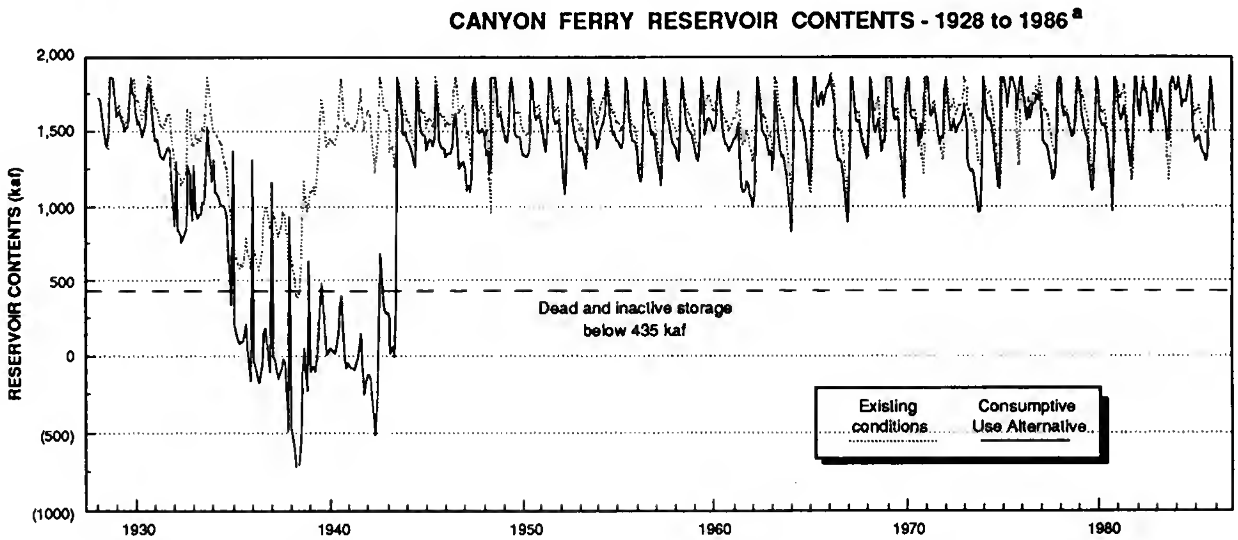
The Board or other agencies with permitting authority could require that certain measures be implemented to reduce or eliminate adverse environmental impacts. Most of the reservation applications contain no description of such measures, and the preceding impact discussion is based on the assumption that no mitigating measures would be implemented, except for BUREC's Virgelle project.

BUREC (undated) described the following measures it planned to use to reduce impacts: an infiltration gallery would be used at the Boggs Island pump station to reduce the transport of nonnative fish from the Missouri River drainage to the Milk River drainage; water would be released from Tiber Reservoir to mitigate flow reductions caused by the diversion when flows in the Missouri River near Virgelle fall below the 90th percentile level; and a plastic liner would be used in the proposed canal to reduce saline seeps.

As described in Chapter Four, Canyon Ferry was built in 1955 to provide water for new irrigation development in the basin above Great Falls without reducing MPC's hydropower generating capacity. The regulated flows provided by the reservoir benefit MPC's hydropower production. Flows that allow MPC to generate power at a level above that possible without Canyon Ferry Reservoir are referred to as "headwater benefits." MPC recognizes and pays BUREC for these benefits. As described in Chapters Four and Six, headwater benefits have steadily declined since 1955 as new irrigation development has reduced Missouri River flows. Development of reservations for consumptive use would further reduce headwaters benefits to MPC. These effects would be greatest under the Consumptive Use Alternative and least under the Instream Alternative.

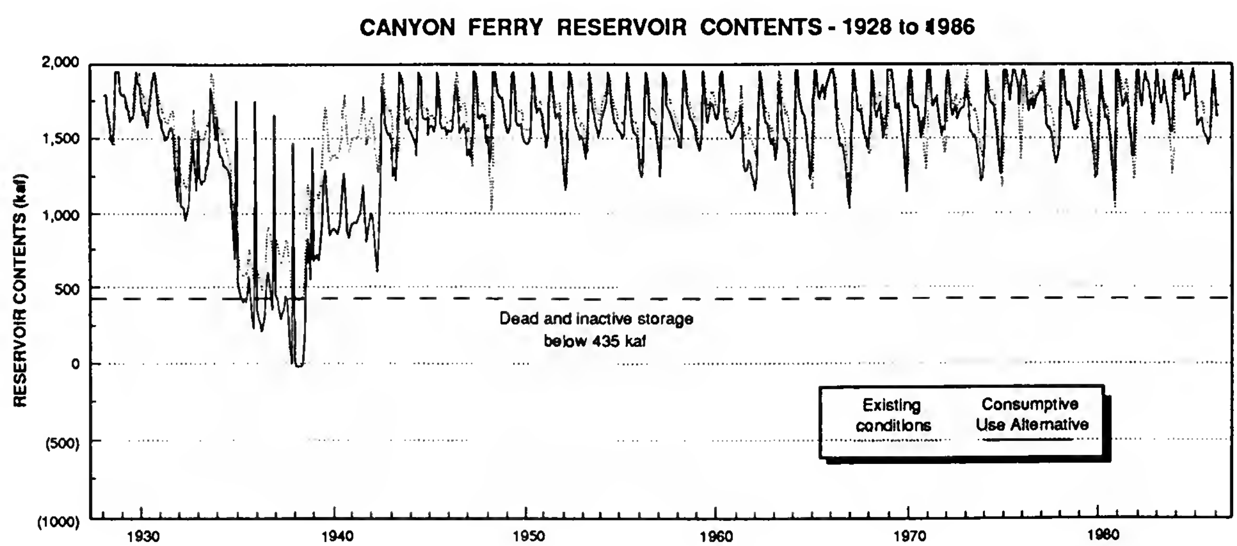
DNRC investigated the possibilities of altering Canyon Ferry Reservoir operations to enhance or maintain MPC headwaters benefits. Two options were evaluated. The first option was to determine whether MPC's headwater benefits could be increased back to the 1955 level given present irrigation development along with the new development included in the Consumptive Use Alternative. The second option was to determine whether headwater benefits could be maintained at existing levels (1986 level of irrigation development) under the Consumptive Use Alternative. These options were investigated through analysis of Canyon Ferry operations and Missouri River flows for 59 water years (1928–1986) using the Missouri River model. Under the first option, it was found that Canyon Ferry Reservoir levels would have dropped below the dead and inactive storage level in 9 consecutive years of the 59, and storage would have been zero in 8 consecutive years (Figure 6-23). Under the second option, Canyon Ferry Reservoir levels would have dropped below the dead and inactive storage level in 4 consecutive years of the 59, and storage would have been zero during 4 consecutive months (Figure 6-24).

Figure 6-23. Hypothetical Canyon Ferry Reservoir contents assuming MPC's headwaters benefits were to be maintained at 1955 levels



[a] Flows are not actual flows for these years but are estimates of what flows would have been 1) if Canyon Ferry Reservoir were in place for the entire period, and 2) if irrigation development was at the 1986 level, or the 1986 level plus the new development included in the Consumptive Use Alternative.

Figure 6-24. Hypothetical Canyon Ferry Reservoir contents assuming MPC's headwaters benefits were to be maintained at 1986 levels



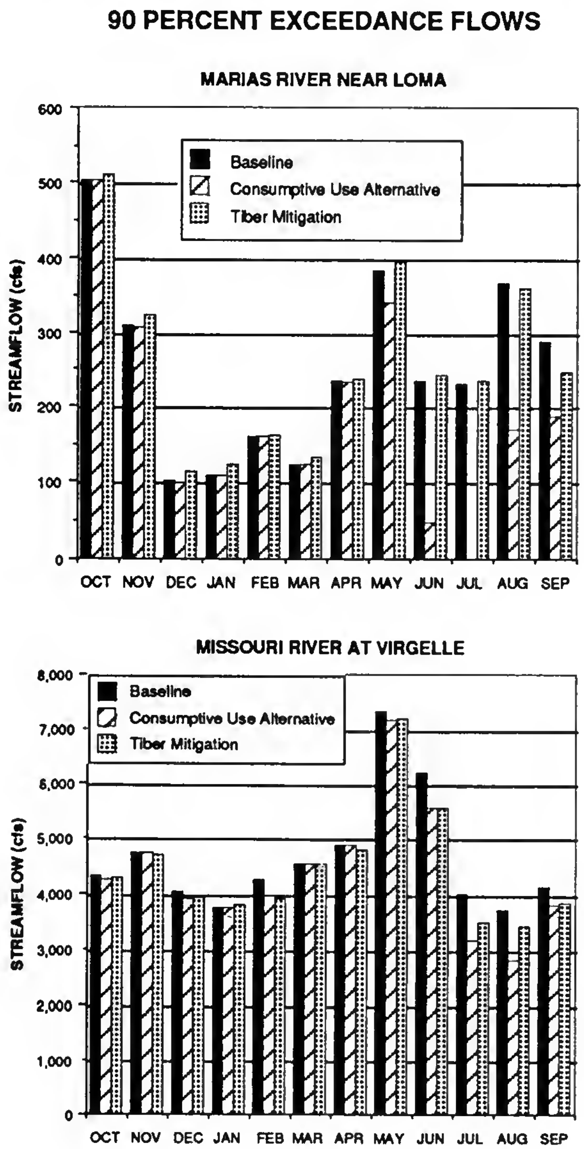
[a] Flows are not actual flows for these years but are estimates of what flows would have been 1) if Canyon Ferry Reservoir were in place for the entire period, and 2) if irrigation development was at the 1986 level, or the 1986 level plus the new development included in the Consumptive Use Alternative.

These results suggest that it is not possible to maintain MPC's headwater benefits at the 1955 level under the Consumptive Use Alternative. However, it may be possible to maintain headwater benefits at the 1986 level under the Consumptive Use and Combination alternatives. These latter options will need to be evaluated further. The results will be included in the final EIS.

DNRC also examined the possibility of using water stored in Tiber Reservoir to reduce depletions that would occur in the lower Marias River and in the wild and scenic reach of the Missouri River under the Consumptive Use and Combination alternatives. Without mitigation, flows in the lower Marias River would decrease substantially and cease during July in the driest 1 year in 10 under the Consumptive Use Alternative.

Under the Consumptive Use Alternative, releasing water stored in Tiber Reservoir could maintain flows above the 90th percentile exceedance rate in the lower Marias River in all months except September. The 90th percentile monthly exceedance flows in the Marias River near Loma are presented in Figure 6-25 under baseline conditions, the Consumptive Use Alternative, and with mitigation. In the Missouri River at Virgelle, use of stored water would increase flows from June through September (Figure 6-25). Releasing stored water would reduce the long-

Figure 6-25. Effects of mitigation on Marias and Missouri River flows under the Consumptive Use Alternative

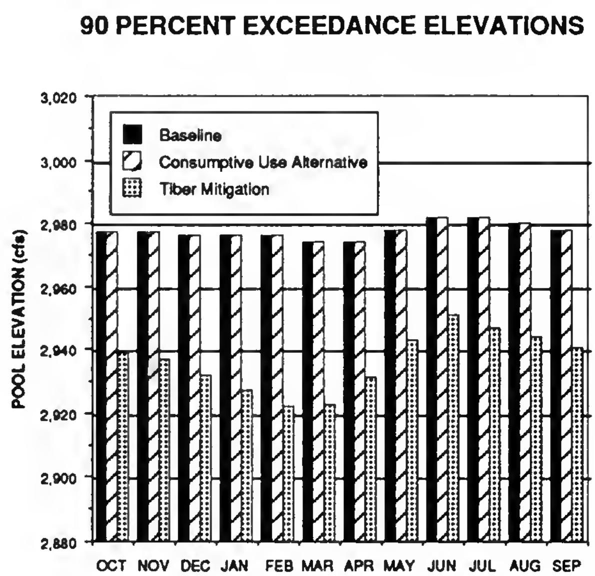


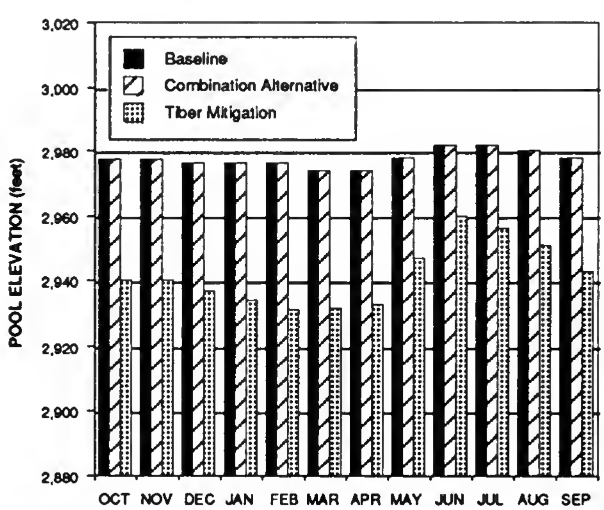
term average Tiber Reservoir pool elevation from 2,983 to 2,970 feet. The minimum elevation would decline 77 feet from 2,970 to 2,893 feet, and the maximum elevation would increase 8 feet from 3,010 to 3,018 feet. Figure 6-26 illustrates the effects this type of mitigation would have on Tiber Reservoir elevations during the driest year in ten.

Under the Combination Alternative, release of water stored in Tiber Reservoir would allow flows in the lower Marias River to remain at or above the 90th percentile exceedance rate in all months (Figure 6-27). In the Missouri River near Virgelle, flows during June, July, August, and September would range from 3,683 to 5,400 cfs (Figure 6-27). Releasing stored water would reduce the long-term average Tiber Reservoir pool from 2,983 to 2,972 feet. The minimum elevation would decline 68 feet from 2,970 to 2,902 feet, and the maximum elevation would increase 8 feet from 3,010 to 3,018 feet. Figure 6-26 illustrates the effects this type of mitigation would have on Tiber Reservoir elevations during the driest year in ten.

DNRC identified other impacts that could be reduced by implementing certain measures. Table 6-

Figure 6-26. Effects of mitigation on Tiber Reservoir elevations under the Consumptive Use and Combination alternatives





50 lists these impacts and measures that could be required by the Board or other agencies with permitting authority to reduce or eliminate these impacts.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

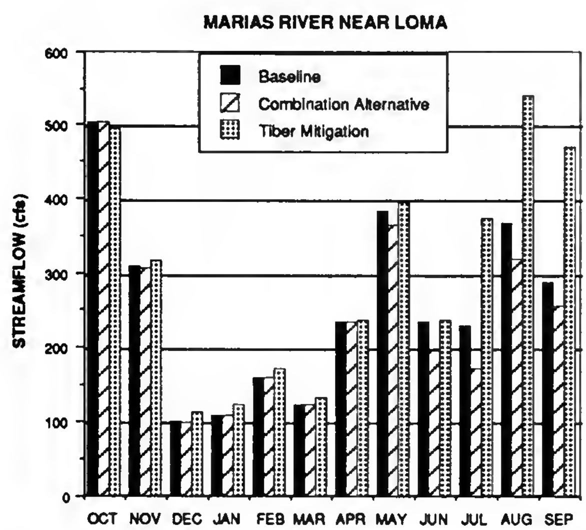
In this discussion, irretrievably committed resources are those that would be lost to the water reservations. For example, hydropower that could not be produced because water was diverted would be lost, but hydropower production theoretically could resume if diversions were to stop.

Irreversible commitment of resources refers to the loss of resources with no possibility of reclaiming them, such as eroded topsoil or concrete used in building dams.

WATER AVAILABILITY

Granting reservations for consumptive uses would commit water for future irrigation and municipal use. Committing water for these uses may preclude other future uses of the water. However,

Figure 6-27. Effects of mitigation on Marias and Missouri River flows under the Combination Alternative



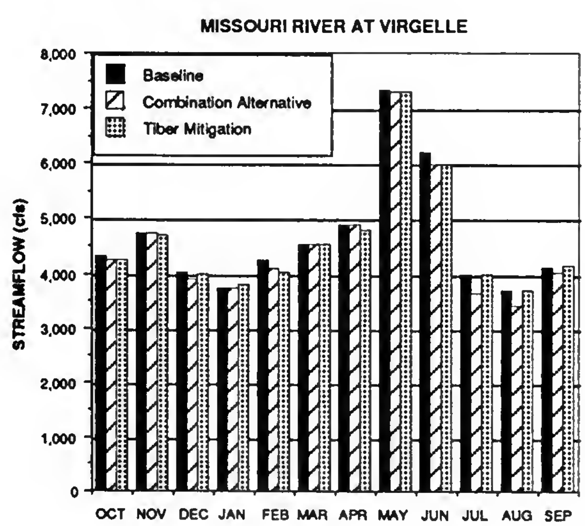


Table 6-50. Measures that could be adopted to reduce Impacts

Type of Impacts	Measures to Reduce Impacts
Irrigation projects conflict with existing land uses, such as residences, highways, and recreation sites.	Redesign the project so conflicts are reduced.
Landowners not benefitting from irrigation projects have not been informed of pipelines and canals crossing their land.	Establish a process for consultation with landowners to resolve land use conflicts.
Diversions for irrigation projects could create hazards to recreational floaters.	Provide "safe passage" to floaters. Provide a portage route around hazardous diversion structures.
Dust, noise, and traffic during construction of projects 3,000 acres or larger could interfere with recreation.	Avoid construction during peak periods of recreational use (weekends and holidays during the summer).
Reservoir levels could drop and make boat ramps and docks unusable.	Extend boat ramps and docks.
Sediment would be introduced to streams during construction of dams and/or diversions.	Conduct instream construction activities during periods of low flow. Build temporary coffer dams around instream construction sites to limit the transport of sediment.
Fish could be killed in pumps for large diversions (pipelines greater than 15 inches in diameter) or canal diversions.	Reduce intake velocities below the swimming speed for game fish and species of special concern in that stream reach.
Consumptive water uses could cause flow to cease in the Marias River, harming fisheries and recreation.	Release stored water from Tiber Reservoir to maintain an instream flow.
Historical, archaeological, or paleontological resources could be destroyed during project construction.	Sites discovered during construction should be evaluated.
Waterlogging of soils due to poor soil drainage.	Install artificial drainage systems to facilitate soil drainage.
Sediment introduced from construction of projects.	Revegetate disturbed areas to reduce erosion.
Decreased soil productivity from mixing soil layers when burying pipelines.	Double-lift soil during trenching; top 12 inches excavated, stored, and replaced separate from subsoil. Pick large rocks prior to topsoil replacement.
Soil compaction and/or rutting from heavy equipment used to install pipelines.	Retain stubble on working side. Suspend construction during wet periods. Post-construction deep ripping of soil along working side.
Erosion on steep slopes and stream banks from pipeline construction.	Clear vegetation immediately before pipeline construction. Install cross ditch and berm structures to divert water flow away from pipeline trench. In severe cases, install sack breakers or subdrains to force seepage to surface. Recontour to original slope and promptly revegetate. Use jute mesh on highly erodible soils with slopes 10 percent or greater.
Conflicts between reservants and existing water users over available water.	Install measuring devices. Hire a water commissioner to monitor diversions and allocate water in accordance with water rights.
Salinity increase from local irrigation projects	Design effective irrigation systems and monitor release.
Destruction of grouse leks.	Conduct studies of proposed projects to determine if leks are present. If present, leave lek and buffer strip (100 meters) around lek.
Disturbance of grouse leks close to agricultural activity.	Peak displaying and mating by grouse takes place in the early morning from dawn to 7:00 a.m. Avoid farming activities in the early morning within 1/2 mile of leks during the grouse breeding season.

Table 6-50 (continued)

Type of Impacts	Measures to Reduce Impacts
Disturbance of nesting raptors.	Avoid farming activities within 1/2 mile of raptor nests during the nesting and brood-rearing period (March-July). Nests screened from activity by terrain and trees would be less susceptible to disturbance and, therefore, could be approached to within 1/4 mile. Raptors, like other wildlife, usually become accustomed to human disturbance, particularly if the disturbance is consistent and follows regular patterns.
Killing big game to alleviate crop damage.	Fence haystacks against deer and elk. Use nonlethal means such as noise or herding to keep wildlife away from crops. Regulate livestock grazing adjacent to crop fields to allow adequate amounts of forage to sustain wildlife over winter.
Destruction of sensitive plants.	Conduct field surveys to determine if sensitive plants are present. If present, do not convert native vegetation to cropland.
Proliferation of noxious weeds.	Consult with county weed board to determine the probability that noxious weeds would become a problem. Monitor for the initial appearance of noxious weeds. Eradicate initial colonies of noxious weeds before they spread, using methods recommended by the county weed board.
Existing wells made unusable by reducing water levels through new consumptive use.	Drill replacement wells.

provisions of the Water Use Act require the Board to review reservations at least every 10 years. If objectives of the reservation are not being met, the Board may extend, modify, or revoke the reservation.

Reservation of water for instream use also may preclude future uses of the water. However, water reserved for instream use is not necessarily permanently unavailable for other uses. The Board may reallocate part or all of an instream flow reservation to another qualified reservant if the Board finds that the water is not required for its original purpose and that the need for the new use outweighs the need for the original reservation. The Board also may revoke or modify the reservation if the reservation is later found to exceed the flows necessary to meet the purpose of the reservation. Water made available in this way could be appropriated for other uses.

Water Quality

Water quality would be altered as reserved water is diverted for irrigation and municipalities. On some streams, water temperature and TDS would increase, dissolved oxygen levels could fall, and arsenic concentrations would increase. These effects might be reversible if reserved water is abandoned and no longer diverted. Instream flow reservations would not directly affect water quality.

Soils

Soils could be lost through erosion. Irretrievable commitments of soil quality would be made where native rangeland is converted to irrigation and where rangeland is disturbed by construction activities as municipal reservations are put to use. Reservations for instream purposes would not affect soil quality.

Land

The conversion of rangeland to irrigated cropland, construction of pipelines, canals, and powerlines, and flooding of land by reservoirs would irretrievably devote affected land to these uses during project lifespan. Instream reservations would have no irretrievable land use effects. Construction of reservoirs and municipal waterworks are generally irreversible land use commitments.

Fisheries and Aquatic Habitat

Aquatic habitat and fisheries could be lost or damaged, especially during periods of low flow, as reserved water is consumed for irrigation and municipal projects. Such effects would be reversible if reserved rights were abandoned permanently and the reserved water returned to the affected streams. Reservations for instream uses would not cause a loss or damage to aquatic resources.

Wildlife

Conversion of wildlife habitat to irrigated agriculture would commit some resources irretrievably. Irretrievable commitments would include crops damaged by wildlife depredation and habitat lost to cultivation while fields are being irrigated and managed to produce crops. Theoretically, the eventual cessation of irrigation followed by gradual reversion to native plant communities would result in reestablishment of native habitat for species unable to use irrigated croplands for food and cover.

If irrigated croplands were abandoned, big game animals would continue to use them, but depredation complaints would decrease and there would be less need for control measures such as damage hunts. Landowners usually are more tolerant of big game use of native range and noncultivated fields than they are of losses to high-value cultivated crops.

Vegetation

Native plants would be eliminated from irrigated cropland. Eventual of irrigation and other crop management would allow native plants to recolonize this land. Full reestablishment of native plant communities would require more than 50 years if no efforts were taken to reseed native species. This time would be much less if active measures are taken to revegetate abandoned croplands with native plants.

Historical, Archaeological, and Paleontological Resources

Construction of irrigation or municipal projects might cause an irreversible loss of historical, archaeological, or paleontological materials that could lead to a better understanding of Montana's past if information contained in these sites were not retrieved. Instream flow would not affect these resources.

Recreation

Use of reserved water for irrigation and municipal projects would cause the loss of recreational opportunities during the period of withdrawal on some streams. This impact could be reversed if reserved water rights were abandoned and water returned to the affected stream. Reservations for instream use would not diminish recreational resources.

Energy and Materials

Energy and fuel committed to irrigation and municipal development and operation would be permanently lost. Some of the materials used in irrigation development, such as irrigation pipe and sprinklers, could be retrieved in the future and reused or recycled. No energy or material resources would be committed as a result of instream use. Projects would require up to 370 GWh of electric power which would not be available for other use.

Socioeconomic Resources

No socioeconomic resources would be irretrievably or irreversibly lost.

IRRETRIEVABLE LOSSES OF NATURAL RESOURCES AND DEVELOPMENT OPPORTUNITIES RESULTING FROM FAILURE TO RESERVE WATER

The Board's decision criteria require consideration of whether failure to reserve water would result in irretrievable loss of a natural resource development opportunity (36.16.107B 4d ARM). If reservations for instream flow and consumptive uses are not granted, there would be no loss of opportunities for water development where water is physically and legally available. Such development could take place under the water use permit system. Depending on the location, timing, and amount of water diverted, new water use permits could cause an irretrievable loss of water quality, fisheries, and opportunities for recreation.

Reservations for instream flow are the only way to protect streamflow for water quality, fish, and recreation on nearly all streams where such reservations are requested. Failure to grant reservations for instream flow could result in losses of these natural resources.

Development opportunities also could be lost if downstream states receive rights to Missouri River flows that originate in Montana. The reservation proceeding was seen by the legislature as a way to protect water for Montana's future needs. Information pertaining to project location and water requirements in the reservation applications could be used

in place of reservations as evidence of Montana's future water needs in negotiations or litigation with downstream states.

If the Board approves reservations for instream flow but does not approve reservations for consumptive uses, less water would be available for future appropriation. As a consequence, development opportunities could be lost at least temporarily, but natural resources would not be irretrievably committed. If no reservations were granted for municipal use, municipalities could condemn water rights and avoid any loss of development opportunity. The Board can reallocate an instream reservation in the future upon finding that all or part of a reservation for instream flow is not required for its purpose, and that another applicant has shown a need outweighing that of the original reservant.

CHAPTER SEVEN

BOARD DECISION CRITERIA

INTRODUCTION

The decision of whether to grant or deny the requested water reservations rests with the Board. To reach its decision, the Board will have to consider the environmental impacts described in Chapter Six, and abide by the statutory criteria explained below.

QUALIFICATIONS AND PURPOSE

Before it can grant a reservation, the Board must find that the applicant is qualified to reserve water and that the purpose of the reservation is a beneficial use (Section 85-2-316(1) and 85-2-316(4)(a)(i), MCA; ARM 36.16.107B(1)). A qualified applicant is any state or political subdivision or agency of the state or federal government. Water may be reserved for existing or future beneficial use or to maintain a minimum flow, level, or quality of water.

NEED

A reservation can only be granted if the Board finds that the reservation is needed (Section 85-2-316(4)(a)(ii), MCA). A reservation is needed if "there is a reasonable likelihood that future instate or out-of-state competing water uses would consume, degrade, or otherwise affect the water available for the purpose of the reservation" (ARM 36.16.107B(2)(a)), or if "there are constraints that would restrict the applicant from perfecting a water permit for the intended purpose of the reservation" (ARM 36.16.107B(2)(c)).

AMOUNT

The Board must determine the amount of water needed to fulfill the purpose of the reservation (Section 85-2-316(4)(A)(iii), MCA). This amount must be based on "accurate and suitable" methods and assumptions. The Board must find that there are no "reasonable cost-effective measures that could be taken within the reservation term to increase the use efficiency and lessen the amount of water required" (ARM 36.16.107(3)).

PUBLIC INTEREST

The Board must find that the reservation is in the public interest (Section 85-2-316(4)(a)(iv), MCA). In making this determination, the Board must weigh and balance

> (a) whether the expected benefits of applying the reserved water to beneficial use are reasonably likely to exceed the costs; (b) whether the net benefits associated with granting a reservation exceed the net benefits of not granting the reservation; (c) whether there are no reasonable alternatives to the proposed reservation that have greater net benefits; (d) whether failure to reserve the water will or is likely to result in an irretrievable loss of a natural resource or an irretrievable loss of a resource development opportunity; and (e) whether there are no significant adverse impacts to public health, welfare, and safety.

The Board also may consider other factors it finds relevant (ARM 36.16.107B(4)).

DILIGENCE

If the purpose of the reservation requires construction of a storage or diversion facility, the applicant shall establish to the satisfaction of the Board that there will be progress toward completion of the facility and accomplishment of the purpose with reasonable diligence in accordance with an established plan (Section 85-2-316(5), MCA).

NO ADVERSE EFFECT ON SENIOR WATER RIGHTS

The proposed reservations must not adversely affect water rights in existence at the time of adoption (Section 85-2-316(9), MCA). A reservation cannot be

granted if the record of the contested case hearing shows that the exercise of senior water rights would be adversely affected. It should be noted that the Board has the option to subordinate the reservations to water use permits issued after the reservation priority date of July 1, 1985. The Board, however, must find that such subordination would not interfere substantially with the purpose of any reservation (Section 85-2-331(4), MCA).

BOARD DECISION CRITERIA

In the following sections, applications are briefly reviewed in light of the Board's criteria for granting reservations. During the contested case hearing, individual applicants have an opportunity to present additional information showing how they have met these criteria.

QUALIFICATIONS AND PURPOSE

Conservation Districts

Conservation districts are political subdivisions of the state which were organized under the state Conservation Districts Act (Section 76-15-101, et seq., MCA). The primary purpose of reservations for the conservation districts is to provide water for irrigation, which is a beneficial use as defined in Section 85-2-102(2)(a), MCA.

Montana Department of Fish, Wildlife and Parks

DFWP is an agency of the state. The primary purpose of the requested reservations is to maintain instream flows to protect fish and wildlife and to sustain adequate levels of water quality. These are beneficial uses under sections 85-2-102(2)(a) and 85-2-316(1), MCA and ARM 36.16.102(3).

Montana Department of Health and Environmental Sciences

DHES is an agency of the state. The purpose of DHES's application is to reserve water to maintain flows in the main-stem Missouri River to dilute naturally occurring arsenic which is a carcinogen. Reserving water to maintain water quality is authorized under sections 85-2-102(1)(6) and 85-2-316(1), MCA, and defined as a beneficial use under ARM 36.16.102(3).

Municipalities

Incorporated municipalities are political subdivisions of the state. The purpose of the municipal reservations is to reserve water for future municipal growth including domestic water supplies, irrigation of lawns, parks, and city grounds; and commercial and industrial uses. Municipal use is defined as a beneficial use in Section 85-2-102(2)(a).

U.S. Bureau of Land Management

BLM is a federal agency. The purpose of BLM's application is to reserve instream flows to protect fish, wildlife, and recreational resources. These are defined as beneficial uses under sections 85-2-102(2)(a) and 85-2-316(1), MCA. BLM also has applied for instream flows to maintain channel stability. Maintenance of a minimum flow, level or quality of water is authorized by Section 85-2-316(1) MCA and is defined as a beneficial use under ARM 36.16.102.

U.S. Bureau of Reclamation

As a federal agency, BUREC is a public entity. The purpose of BUREC's application is to divert water from the Missouri River to the Milk River for new and supplemental irrigation, municipal and stock use, and for the Lake Bowdoin National Wildlife Refuge. These are considered beneficial uses as defined in Section 85-2-102(2)(a), MCA.

NEED

Conservation Districts

Reservations would allow conservation districts to establish an early priority date for water to be used in the future. If the conservation districts do not have water reservations, they still might be able to develop proposed projects through the water permitting process. Permits generally require that the development be completed in 2 to 3 years. However, due to present economic constraints, the irrigation development proposed by the conservation districts may not occur for some time. In the meantime, if the needed water were not reserved, it could be appropriated by competing users in Montana and in downstream states. An interstate allocation proceeding in the Missouri River basin is unlikely in the near future. However, competing water users, including applicants who have applied for instream flow purposes, could limit the amount of water available for future appropriation.

Montana Department of Fish, Wildlife and Parks

Under Montana law, a water right for instream uses can only be secured by obtaining a water reservation. A temporary water leasing program is underway which allows leasing of existing water rights on 10 streams for instream flows in order to maintain or enhance the fisheries. This pilot program is designed to relieve stress to fisheries in streams that are subject to low flows. Therefore, its applicability is very limited throughout the basin. If DFWP does not obtain a reservation, the water it is requesting could be appropriated for consumptive uses. In some instances, this could have severe detrimental effects on fish, wildlife, recreation, and water quality. It is possible that Murphy rights, hydropower water rights, and the high arsenic concentration in the Missouri and Madison rivers may preclude some consumptive use projects and thus provide some level of instream flow protection.

Montana Department of Health and Environmental Sciences

Present arsenic concentrations in the Missouri River basin exceed the instream standard adopted by the Montana Board of Health and Environmental Sciences. Existing concentrations are far in excess of the standard in the Madison River (12,900 times greater than the standard at West Yellowstone, 3,400 times greater than the standard at Three Forks) and in the Missouri River (1,500 times greater than the standard at Toston, and 700 times greater than the standard at Landusky). Additional consumptive water use would decrease the amount of water available to dilute arsenic. If present dilution of arsenic in the Missouri River is not maintained, people who drink this water face increased cancer risks and treatment costs. Under Montana law, a water right for instream flow to protect water quality can only be obtained through a water reservation.

Municipalities

A reservation is the only means to obtain an early priority date for water that will be needed to meet projected municipal growth in the basin over the coming decades. In the future, all available water in the basin may be appropriated by competing agricultural, industrial, and instream users. Without a reservation, municipalities may have to go through a costly process of buying or condemning existing water rights to meet increasing demands.

When the City of Bozeman submitted its application, it was uncertain whether Hyalite Reservoir would be enlarged. Therefore, the city disregarded Hyalite as a potential source of water in its application. The enlargement of Hyalite Reservoir has been initiated and will increase Bozeman's annual entitlement from 3,168 acre-feet to 5,179 acre-feet for an increase of 2,011 acre-feet. Consequently the Board may wish to consider a smaller reservation for the City of Bozeman.

U.S. Bureau of Land Management

BLM requested year-round instream flows for protecting fish and wildlife habitat and at least a brief period of bankfull flow every second year for channel maintenance. If BLM does not obtain a reservation, the water requested could be appropriated for consumptive uses, and fish, wildlife, and recreational resources could be adversely affected on some streams.

U.S. Bureau of Reclamation

Milk River irrigators face water shortages in 4 years out of 10. In the past, the water supply in the basin has been 20 percent less than needed to meet existing demand, with an average shortfall of 121,500 acre-feet per year. Federal reserved rights claims by tribes on the Fort Belknap and Rocky Boy's Indian reservations and by the U.S. Fish and Wildlife Service for Bowdoin Wildlife Refuge have an earlier priority date than most nonfederal water rights in the Milk River drainage. The Province of Alberta also has plans to develop more water from the Milk River under its entitlement based on the 1909 Boundary Waters Treaty. Together, these factors could increase water supply problems in the basin. Also, potential users could appropriate Missouri River flows so that water would not be available to divert into the Milk River basin. The diversion project proposed by BUREC at Virgelle would supply an additional 89,000 acre-feet per year to the drainage, thereby helping to ease water supply problems. Some of the water has been earmarked to satisfy federal reserved rights for the tribes on the Fort Belknap and Rocky Boy's reservations, and for the Lake Bowdoin National Wildlife Refuge.

AMOUNT

Conservation Districts

The amounts of water requested by the conservation districts are based on the requirements of

individual irrigation projects (Table 3-1). Basically, the water needed for each project was calculated by multiplying the project acreage by the estimated crop consumptive use requirement per acre, and then dividing this number by the irrigation system efficiency. Four general types of irrigation systems were included in the conservation district applications; center pivots sprinklers, side-roll sprinklers, hand-line sprinklers, and flood systems.

Most projects included in conservation district applications below Canyon Ferry Dam were designed to use efficient sprinkler irrigation systems. Applications for conservation districts above Canyon Ferry Dam include projects with sprinkler irrigation systems, and a few others which were designed for less efficient flood-irrigation systems.

Some of the conservation district applications include water storage projects. The design of these projects incorporates the intended use of the reservoir, estimated water yields of the drainage, reservoir evaporation, and dam size. Where reservoirs where designed to supply water for irrigation, the predicted reservoir yield was used in determining the amount of land that could be irrigated. Four reservoirs would be designed to provide water for fish, wildlife, recreation, or fire protection.

In developing the applications, the conservation districts and DNRC examined many potential irrigation projects. However, only those projects considered to be economically feasible at least 10 percent of the time were included in the final applications. In the draft EIS, DNRC included all proposed projects in the application under the Consumptive Use Alternative, but the Combination Alternative was designed to include only those proposed projects that were economically feasible at least 50 percent of the time.

Irrigation projects were included in the conservation district applications if sufficient water is physically available at the points of diversion to satisfy individual projects. On some streams where there is more than one proposed irrigation project, total proposed diversion rates would exceed the flow of the stream in dry years.

Montana Department of Fish, Wildlife and Parks

DFWP used seven different methods to determine the amount of streamflow necessary to protect fish, wildlife, recreation, and water quality, as described in Appendix G. Table 3-2 identifies the amount of water DFWP requested. On some gauged streams (Table 5-1) DFWP requested more than half the average annual flow, which is the maximum allowed under Section 85-5-331, MCA.

DFWP used the Wetted Perimeter Inflection Point (WETP) method most frequently. This method determines the amount of water needed to cover riffle areas in specific stream reaches. DFWP assumed that riffles are the most productive areas of a stream, where propagation and growth of fish-food organisms occur. If enough flow remains in a stream to keep riffle areas wet, then most of the food-producing areas of a stream would be maintained. Generally the amount of water requested on streams where the WETP method was used is the amount required to cover riffles. Reserving this amount of flow also would protect other types of stream habitat, such as pools and bank cover.

The WETP method provides a reasonable estimate of the amount of stream bottom in riffles that remains wet at specific streamflows. However, on most streams where DFWP used this method, it has not been demonstrated that there is a precise relationship between wetted perimeter and the maintenance of aquatic habitat, or the number and total weight of fish a stream can support. In its application, DFWP stated that two flow levels, the upper and lower inflection points, are thought to bracket flows needed to maintain high and low levels of aquatic habitat. "Inflection points' are discussed in Appendix G.

The Fixed Percentage Method was used on 27 streams. Desirable flow amounts are assumed to equal a fixed percentage of the estimated flow. While this method can be used as a general indicator of flows necessary to protect aquatic habitat, the assessment it provides is less sensitive to conditions in individual streams than the WETP method.

DFWP used two methods for determining its flow request on spring creeks. On some of the 17 spring creeks where it requested reservations, DFWP requested year-round allocations of the lowest average monthly flows, and on others it requested the average annual flows. DFWP considers these flows adequate to maintain aquatic habitat. However, little information was included in DFWP's application to support this conclusion.

On three streams, DFWP defined a relationship between flow rate and numbers of game fish and

used this information to request instream flows sufficient to support a thriving fishery. This approach is among the most reliable methods for determining instream flow needs but is very expensive and time consuming. Factors other than flow rates may limit fish populations on some streams, and this approach would not be appropriate in those instances.

On the Missouri River from Fort Benton to Fort Peck Reservoir, DFWP requested instream flows based on the seasonal requirements of resident and migratory fish and nesting geese. These need estimates were developed with consideration of the amount of water required for successful migration of paddlefish and rearing of young game and forage fish, and for protection of goose nesting on islands. This method of quantifying instream flow needs is more detailed than the WETP analysis.

DFWP also requested all remaining unappropriated water on four streams to protect water quality and fisheries in the East Gallatin River. DFWP suggested that urban runoff from the Bozeman area pollutes the East Gallatin River, and that high flows in tributaries would help dilute the incoming pollution.

Requests by DFWP included all unappropriated water on three tributaries of the Madison River below Hebgen Dam to ensure adequate flow in the Madison River when water is not being released from the dam.

DFWP requested reservations for Bean Lake and Antelope Butte Swamp. The amount requested for the lake was equal to the amount necessary to replace the water that the lake loses to evaporation and seepage, and the volume of the lake itself. The amount requested for Antelope Butte Swamp was the amount necessary to replace the water that evaporates from the swamp each year.

Montana Department of Health and Environmental Sciences

DHES has requested half the average annual flow of the Missouri River at four points as summarized in Table 3-3. Because any new consumptive water uses could increase arsenic concentrations in the Missouri River, DHES indicated that all remaining unappropriated water is required to protect public health in the basin. However, Section 85-5-331, MCA limits instream reservations to half the average annual flow of gauged streams, so DHES is requesting only this amount.

Municipalities

Each municipality has different water requirements. In general, the municipalities based their reservation requests on the amount of water that their respective service area populations will need by the year 2025. Future needs where generally calculated by multiplying the city's predicted 2025 service area population by the expected water consumption rate per person for that area. This was then compared to the city's existing water supply and water rights to determine how much water to request. Practical considerations regarding each city's water supply and distribution systems also were taken into account in determining amount. In some instances, municipalities are requesting reservations for new water supplies due to problems with present sources such as poor water quality. Three municipalities requested water for irrigating parks. The amounts requested by the municipalities are summarized in Table 3-4.

The municipal applications were prepared by two private engineering firms with DNRC reviewing their methods. All population projections were based on figures from the 1980 census. Based on information from the 1990 census, 11 of the 18 projections of population growth, and the associated amounts of water requested, may be too high (refer to Table 6-49).

U.S. Bureau of Land Management

The amount of water BLM requested is summarized in Table 3-5. For each stream, BLM requested a year-round minimum flow for protecting habitat, and a bankfull flow for at least a brief period every other year for channel maintenance. BLM used DFWP's WETP method to determine flows needed for habitat maintenance. The bankfull discharge BLM requested is the maximum amount of water a stream can carry without overflowing its banks. Bankfull discharges were estimated with standard USGS procedures involving measurement of stream channel characteristics including slope and area. Typically, the spring runoff flow that occurs once every 2 years on average is similar to the bankfull discharge.

U.S. Bureau of Reclamation

The Milk River water supply model developed by DNRC and BUREC (BUREC undated) was used to estimate water shortages and their frequency in the basin and to determine how BUREC's proposed Virgelle diversion project could be used to address

these problems. Shortage estimates were based on the number of acres of irrigated land that currently do not receive a full water supply each year. Crop irrigation requirements and irrigation efficiencies were used to establish supplemental water requirements for these lands. However, water requested for supplemental irrigation would service 8,000 acres that presently do not meet DNRC's guidelines for irrigable lands due to problems with soils, drainage, or topographic constraints.

DNRC and BUREC estimated the number of new irrigation projects that would use reserved water on Indian reservations. The water requested for the Lake Bowdoin National Wildlife Refuge is the amount necessary to reduce salinity which has decreased waterfowl production in the lake. The water BUREC requested for stock watering is the amount necessary to replace water that BLM would store in small reservoirs on tributaries. A relatively small amount of water would be used to meet the needs of the City of Chinook.

It is difficult to predict whether the requested amount is reasonable without knowing the amount of water that will be saved through implementation of present and planned conservation measures in the Milk River basin. The irrigation districts are increasing the efficiency of the existing canals and on-farm irrigation systems and this will reduce the water shortage. It is also difficult to predict the amount of water the tribes on the Fort Belknap and Rocky Boy's Indian reservations will need until their federal reserved water rights are quantified.

PUBLIC INTEREST

In this section DNRC presents two comparisons to assist the Board in its evaluation of the reservation requests. The first compares the relative costs and benefits of consumptive use and instream use considered under the three alternatives described in Chapter Five. The second comparison examines whether the benefits exceed the costs for individual water reservations based on the value of an acre-foot of water for consumptive use or instream use in each subbasin.

BENEFITS AND COSTS UNDER THE ALTERNATIVES

The analysis of the three alternatives focuses on the consequences of emphasizing different water reservations. This analysis, based on results in Chapter Six, is general because actual costs and benefits cannot be known until after the Board determines which reservations are to be granted. Also, costs and benefits could change following granting of the reservations if the Board subsequently approves changes to the conservation districts' management plans, or modifies instream flows, or if DNRC approves changes in existing water rights. The estimated net present values for benefits and costs in these analyses are based on a 4.6 percent interest rate over a 70-year period (see Glossary for definitions).

BENEFITS

NEW IRRIGATION

DNRC analyzed the economic and financial feasibility of the irrigation proposals. Information used in the analysis included recorded crop yields, prices, and production costs. DNRC compared returns with costs for 300 scenarios of various prices, costs, and crop yields in the future. All but one of the proposed projects would grow alfalfa for hay. The other project would grow seed potatoes. DNRC's analysis is described in Tubbs et al. (1989). The irrigation benefits shown in Table 7-1 are the median value today of 70 years of returns less costs, meaning that half the 300 scenarios analyzed have higher net returns and half have lower net returns.

INSTREAM USES

None of the reservations included under the three alternatives would increase the value of instream uses, but could prevent future depletions thereby maintaining the existing level of instream values. Under existing conditions, the total value of recreation in the basin is $144 million per year (Duffield, et al. 1990). Current annual hydropower production in the Missouri Basin under average water conditions is 12,710 GWh per year. Of this amount, 3,550 GWh per year is produced at dams in Montana and 9,160 GWh per year is produced at federal dams in North and South Dakota.

The value of hydroelectric power production, based on replacement costs of 50 and 100 mills per kWh, is $180 to $355 million per year in Montana and $460 to $920 million per year in the Dakotas. The power from Pick-Sloan dams is currently sold at cost-based rates that are around 10.5 mills per kWh. MPC does not market its hydropower separately, but the cost of production is about 22.6 mils/kWh averaged over all MPC hydroelectric dams (MPC 1990). Leaving water instream also has value for preserving water quality, but this value has not been quantified.

MUNICIPAL USE

Water for municipal uses is worth at least what people are now paying for it. DNRC used Helena's rate of $2.47 per thousand gallons as a estimate of this value. The annual use proposed by each municipality and the associated costs are shown in Table K-6 in Appendix K. The municipal benefits shown in Table 7-1 are the value today of 70 years of the proposed municipal use valued at $2.47 per thousand gallons, less the costs shown in Table K-6. Benefits are $343.2 million and are the same under the three alternatives.

COSTS

REDUCED RECREATION

All three alternatives would result in lower streamflows. Lower flows would reduce future water-based recreation below the levels that would occur with present flows levels. The estimated annual value of lost recreation due to lower flows under each alternative is shown in Table 6-42. Table 7-1 shows the cost today of 70 years of lost recreation. Costs for lost recreation are highest under the Consumptive Use Alternative ($70.3 million) and lowest under the Instream Alternative ($6.7 million).

REDUCED HYDROPOWER PRODUCTION

Streamflow would be reduced under all three alternatives. Lower flows would reduce power production at dams in the Missouri River basin. Annual losses of hydropower production under each alternative are shown in Table 6-43. Table 7-1 shows what it would cost today to replace 70 years of lost generation under the three alternatives. These values range from $213.4 million under the Consumptive Use Alternative to $27.6 million under the Instream Alternative. As explained on page 144, the cost of replacement power is likely to rise over time. The values in Table 7-1 are therefore conservative.

REPLACING MUNICIPAL AND IRRIGATION POWER USE

DNRC's economic analysis used the current electric power rates in calculating costs of proposed irrigation and municipal projects. As explained in Chapter Six, the cost of supplying this additional power would be higher than current rates. The annual difference between the cost of additional power for the proposed projects and what applicants would pay for the power is shown in Table 6-43. Table 7-1 shows the cost of the subsidy that the ratepayer would pay over 70 years. It would range from $40.9 million under the Consumptive Use Alternative to $9.1 million under the Instream Alternative. Since power costs are likely to rise over time, the values in Table 7-1 are conservative.

LOWER WATER QUALITY

Arsenic concentrations in the Madison, Gallatin, Milk, and Missouri rivers would increase under each of the three alternatives analyzed. The increase would

Table 7-1. Economic gains and losses under the three alternatives ($ million)[a]

Use/Subbasin	Consumptive Use	Instream	Combination
Irrigation			
Headwaters	76.9	0.0	55.3
Upper Missouri	9.1	7.5	20.2
Marias/Teton	22.7	23.5	24.3
Middle Missouri	25.4	7.7	12.0
Total	134.1	38.7	111.9
Municipal			
Headwaters	73.0	73.0	73.0
Upper Missouri	243.7	243.7	243.7
Marias/Teton	16.0	16.0	16.0
Middle Missouri	10.6	10.6	10.6
Total	343.2	343.2	343.2
Recreation			
Headwaters	-32.4	0.0	-15.8
Upper Missouri	-14.1	- 4.3	-11.0
Marias/Teton	- 4.4	- 0.4	- 1.1
Middle Missouri	-19.4	- 2.1	- 7.9
Total	-70.3	- 6.7	-35.7
Hydropower Production			
Headwaters	0.0	0.0	0.0
Upper Missouri	-58.6	-13.3	-26.5
Marias/Teton	0.0	0.0	0.0
Middle Missouri	-32.1	-1.1	-12.2
Downstream	-122.7	-13.3	-48.6
Total	-213.4	-27.6	-87.3
Replacement Power			
Headwaters	- 6.7	- 0.1	- 1.2
Upper Missouri	- 7.4	- 2.7	- 2.7
Marias/Teton	- 8.1	0.0	- 1.6
Middle Missouri	-18.7	- 6.3	-12.6
Total	-40.9	- 9.1	-18.0
TOTAL	152.7	338.5	314.1

[a] Positive numbers represent benefits and negative numbers represent costs. All figures are the value today of 70 years of future impacts.

be highest under the Consumptive Use Alternative and lowest under the Instream Alternative. While arsenic concentrations are expected to increase as a result of consumptive uses, DNRC was unable to quantify the increases in arsenic concentrations, or the resulting increased health risks. Health effects are discussed in Chapter Six.

LOST DEVELOPMENT OPPORTUNITIES

Any of the proposed reservations could impose costs if they preclude other water uses. These future uses are not known and therefore these costs cannot be quantified.

Except for the streams identified in Appendix A where water use permits have been issued since 1985 for consumptive uses, no other new uses have been identified on these streams. DNRC did not examine the effects the reservation applications would have on water use permits issued since 1985. This analysis would be conducted if the Board considers subordinating reservation applications to the post-1985 permits.

COMPARISON OF BENEFITS AND COSTS FOR DNRC'S ALTERNATIVES

Table 7-1 shows the costs and benefits associated with the three alternatives. All three alternatives have increased consumptive use for irrigation and cities and towns. All three alternatives would result in lower streamflows for recreation and power production, and require replacing power used by irrigation and municipal water systems. The net benefits are highest in the Instream Alternative and lowest in the Consumptive Use Alternative.

Table 7-2 shows the benefits and costs that would result from reservation of water for municipal and irrigation purposes included under each alternative. The costs imposed by increased irrigation exceed the benefits by $188.6 million under the Consumptive Use Alternative, by $2.8 million under the Instream Alternative, and by $27.2 million under the Combination Alternative.

The high costs are due to the large amounts of water consumed. Large benefits are attributable to the municipal reservation because of the value of water for such use and the small effect that the withdrawals would have on other downstream uses, including hydropower production. The benefits of municipal water use are $343.2 million under each of the three alternatives. This is significantly larger than any of the other benefits. Only $1.9 million of the costs result from the small amounts of water to be consumed through municipal water use.

Table 7-2. Benefits and costs of reservations for municipal use and irrigation ($ million)[a]

	Alternatives		
	Consumptive Use	Instream	Combination
Irrigation			
benefits	134.1	38.7	111.9
costs	-322.7	-41.5	-139.1
net	-188.6	-2.8	-27.2
Municipal			
benefits	343.2	343.2	343.2
costs	-1.9	-1.9	-1.9
net	341.3	341.3	341.3

[a] Positive numbers represent benefits and negative numbers represent costs.

BENEFITS AND COSTS OF GRANTING RESERVATIONS FOR INDIVIDUAL PROJECTS

The Board may grant a reservation for future consumptive uses, or to protect existing instream uses. A reservation for future consumptive use has benefits because it guarantees that water will be available for development of the proposed use. A reservation for instream uses has benefits because it provides legal protection for continued instream water use. In both cases, granting a reservation imposes costs because it may preclude other uses of the reserved water. The benefits of granting a reservation exceed the costs if the value of the water in its proposed use is greater than its value in uses that would be precluded by the reservation.

Two cases are considered in this comparison. First, is the case when proposed reservations do not conflict with other identified future uses. The second is the case where proposed reservations do conflict with other identified future uses, including other reservation requests. All of the requests with no known conflicts are instream requests. These requests are all upstream of reaches where consumptive uses are proposed. There also are cases of two instream applications on the same stream, but they would not conflict with each other because the same water can be used to partially or completely satisfy both requests.

All of the consumptive requests have at least potential conflicts. Many streams have two or more consumptive use requests, and in some cases there is not enough water to satisfy all the proposed reservations. All the consumptive requests conflict with instream requests, either on the stream reach where water is being requested or downstream. Consumptive use requests on a tributary also can conflict with other consumptive use requests and existing hydropower uses downstream. Instream requests can conflict with consumptive use requests on the same stream or on tributaries upstream.

RESERVATION REQUESTS WITH NO KNOWN CONFLICTS

There are 273 instream use requests on streams or stream reaches that have no conflicts with proposed consumptive use reservation requests. Except for the drainages identified in Appendix A where water use permits have been issued since 1985, no other new water uses have been proposed for water from these streams. The value of water for instream uses is shown in Tables K-1 and K-2 in Appendix K. The reservation requests with no known conflicts are shown in Table K-3 in Appendix K. The benefits of granting these requests would exceed the costs unless other new water uses with higher values are identified.

REQUESTS WITH IDENTIFIED CONFLICTS

There are 239 reservation requests on stream segments where there are both instream and consumptive use requests. Sixty-two proposed irrigation projects have a value per acre-foot of water that exceeds the instream values and 157 proposed irrigation projects have an acre-foot value that is less than the instream values. The value of an acre-foot of water for all 19 municipal reservations exceeds the value for instream flow and proposed irrigation projects. Instream flow values are greatest in the Headwaters Subbasin where the recreation value is the highest and where each acre-foot of water can be used to generate hydroelectricity at the downstream hydropower facilities. The instream values progressively decline with distance downstream.

On each stream or stream reach, the proposed uses that would give the greatest net benefits are determined, part, by the amount of water available. However, water availability may not be definitively known before the Board acts on the reservation requests.

When two reservation requests can not both be granted because they conflict, the cost of granting one request is the value of the foregone benefits of the other. The net benefits will be greater than costs for granting the request with the higher valued water use and less than costs for granting the other request. On streams with three or more requests, the net benefits will be greatest from granting as many requests, starting with the highest valued, as there are water for.

Table K-4 in Appendix K shows consumptive use requests that conflict with other requests, the value of water for the proposed use, and the value of water for conflicting instream uses. Table K-5 in Appendix K shows instream requests that conflict with other consumptive use requests and the value of water in the instream reach.

REASONABLE ALTERNATIVES WITH GREATER NET BENEFITS

The alternatives presented in this draft EIS are only three of many ways the Board could allocate water among the reservation applicants. Some other combination of reservations probably would have greater net benefits than any of the three alternatives examined by DNRC.

DNRC identified some cases where a modified request would have greater net benefits. The net benefits of the Bureau of Reclamation's request for diversion at Virgelle would be increased by dropping the approximately 1,000 acres of land that are not suitable for irrigated alfalfa production. Other irrigation projects with serious land use problems, listed in Chapter Six, could have greater net benefits if modified.

In some cases, it may be cheaper to reduce municipal water use than to increase municipal water supplies. This could be accomplished through two main strategies: conservation measures, including repairs to existing water supply and distribution systems, and metering of municipal water use. Table K-7 in Appendix K lists characteristics of municipal water systems where improvements might be cost-effective.

APPENDIX A

SUMMARY OF WATER RIGHTS CLAIMS, PERMITS, AND PERMIT APPLICATIONS IN THE MISSOURI BASIN

Table A-1. Headwaters subbasin existing claims

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
GALLATIN	MUNICIPAL AND DOMESTIC	184	62.7	20,733.3	3,361.3
	IRRIGATION	1,806	5,431.5	1,412,447.3	751,474.0
	STOCK	1,281	27.8	0.0	20.0
	FISH AND WILDLIFE	126	7,756.6	978,678.1	0.0
	POWER GENERATION	38	557.1	386,474.0	0.0
	OTHER	22	28.9	9,549.4	0.0
	DRAINAGE TOTALS	3,457	13,864.6	2,807,882.1	754,855.3
MADISON	MUNICIPAL AND DOMESTIC	37	9.8	5,927.6	43.7
	IRRIGATION	858	4,047.1	738,940.2	264,431.3
	STOCK	661	0.3	1.9	0.0
	FISH AND WILDLIFE	60	10,306.5	1,960,109.5	0.0
	POWER GENERATION	9	108,032.0	1,150,344.9	0.0
	OTHER	44	172.3	48,741.4	370.0
	DRAINAGE TOTALS	1,669	122,568.0	3,904,065.5	264,845.0
JEFFERSON	MUNICIPAL AND DOMESTIC	56	115.7	8,069.1	209.4
	IRRIGATION	1,200	4,428.9	572,036.9	385,710.5
	STOCK	715	10.3	11,771.4	0.0
	FISH AND WILDLIFE	27	54.5	8,487.0	0.0
	POWER GENERATION	15	518.2	370,679.6	0.0
	OTHER	164	1,116.0	212,122.7	0.0
	DRAINAGE TOTALS	2,177	6,243.6	1,183,166.7	385,945.3
BIG HOLE	MUNICIPAL AND DOMESTIC	31	42.1	20,902.3	353.0
	IRRIGATION	1,563	20,856.5	3,414,195.5	850,879.1
	STOCK	779	2,715.8	126,675.7	0.0
	FISH AND WILDLIFE	4	86.2	15,091.5	0.0
	POWER GENERATION	3	1,252.5	912,800.0	0.0
	OTHER	79	1,252.3	334,391.0	0.0
	DRAINAGE TOTALS	2,459	26,205.4	4,824,056.0	851,232.1
RUBY	MUNICIPAL AND DOMESTIC	27	2.0	596.4	48.2
	IRRIGATION	903	2,132.5	295,042.5	519,113.9
	STOCK	475	1.2	20.2	0.0
	FISH AND WILDLIFE	21	1,981.0	1,516,630.0	0.0
	POWER GENERATION	5	32.3	22,209.5	0.0
	OTHER	165	2,483.3	762,829.5	0.0
	DRAINAGE TOTALS	1,596	6,632.3	2,597,328.1	519,162.1
BEAVERHEAD/ RED ROCK	MUNICIPAL AND DOMESTIC	47	2,839.1	8,628.0	57.9
	IRRIGATION	1,817	12,004.2	2,961,533.3	1,295,953.0
	STOCK	1,067	1,170.2	131,239.0	0.0
	FISH AND WILDLIFE	128	6,533.1	825,318.7	0.0
	POWER GENERATION	5	2,835.3	140,028.6	0.0
	OTHER	48	3,155.4	157,423.3	0.0
	DRAINAGE TOTALS	3,112	28,537.3	4,224,170.9	1,296,010.9
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	382	3,071.4	64,856.7	4,073.5
	IRRIGATION	8,147	48,900.7	9,394,195.6	4,067,561.8
	STOCK	4,978	3,925.5	269,708.2	20.0
	FISH AND WILDLIFE	366	26,718.0	5,304,314.8	0.0
	POWER GENERATION	75	113,227.3	2,982,536.6	25.4
	OTHER	522	8,208.1	1,525,057.3	370.0
	GRAND TOTALS	14,470	204,051.0	19,540,669.2	4,072,050.7

Table A-2. Headwaters subbasin permits 1973 through June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
GALLATIN	MUNICIPAL AND DOMESTIC	4	3.3	1,333.5	5.3
	IRRIGATION	20	16.1	3,432.9	875.6
	STOCK	4	0.1	1.5	4.0
	FISH AND WILDLIFE	9	10,023.1	8,051.2	0.8
	POWER GENERATION	3	16.6	9,738.9	0.0
	OTHER	3	0.2	1.7	0.8
	DRAINAGE TOTALS	43	10,059.4	22,559.7	912.5
MADISON	MUNICIPAL AND DOMESTIC	1	0.2	20.0	0.0
	IRRIGATION	16	41.2	3,196.6	1,331.1
	STOCK	3	0.1	8.8	0.0
	FISH AND WILDLIFE	8	8.9	2,060.4	0.0
	POWER GENERATION	1	1.5	5.6	0.0
	OTHER	8	0.9	203.9	3.3
	DRAINAGE TOTALS	37	52.8	5,495.3	1,334.4
JEFFERSON	MUNICIPAL AND DOMESTIC	1	0.1	1.5	0.0
	IRRIGATION	20	25.9	2,880.6	1,388.4
	STOCK	2	0.1	2.9	0.0
	FISH AND WILDLIFE	1	34.5	2.1	0.0
	POWER GENERATION	5	126.4	33,680.8	0.0
	OTHER	7	2.9	803.8	1.0
	DRAINAGE TOTALS	36	189.9	37,371.7	1,389.4
BIG HOLE	IRRIGATION	9	15.3	1,225.9	479.0
	STOCK	4	0.1	63.8	0.0
	OTHER	4	3.5	608.8	3.0
	DRAINAGE TOTALS	17	18.9	1,898.5	482.0
RUBY	IRRIGATION	3	11.1	1,081.5	464.0
	STOCK	2	0.1	6.6	0.0
	FISH AND WILDLIFE	2	2.2	1,652.7	0.0
	OTHER	3	14.2	10,164.9	1.8
	DRAINAGE TOTALS	10	27.6	12,905.7	465.8
BEAVERHEAD/ RED ROCK	IRRIGATION	2	2.5	498.3	166.0
	STOCK	6	0.1	18.4	0.0
	FISH AND WILDLIFE	2	1.6	542.0	0.0
	POWER GENERATION	2	562.5	324,075.0	0.0
	OTHER	2	1.2	132.0	0.0
	DRAINAGE TOTALS	14	567.9	325,265.7	166.0
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	6	3.5	1,355.0	5.3
	IRRIGATION	70	112.0	12,315.8	4,704.1
	STOCK	21	0.2	102.1	4.0
	FISH AND WILDLIFE	22	10,070.3	12,308.3	0.8
	POWER GENERATION	11	707.1	367,500.3	26.0
	OTHER	27	23.0	11,915.1	9.8
	GRAND TOTALS	157	10,916.1	405,496.6	4,750.0

Table A-3. Headwaters subbasin permits and applications post June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
GALLATIN	MUNICIPAL AND DOMESTIC	1	0.1	20.0	0.0
	IRRIGATION	9	15.4	2,047.4	952.5
	STOCK	3	0.0	7.7	0.1
	FISH AND WILDLIFE	19	25.7	15,210.4	0.0
	OTHER	4	0.4	168.9	2.7
	DRAINAGE TOTALS	36	41.6	17,454.4	955.3
MADISON	IRRIGATION	3	5.6	602.4	134.0
	STOCK	1	0.1	0.2	0.0
	FISH AND WILDLIFE	5	10.3	7,002.4	0.0
	OTHER	2	2.0	852.9	0.0
	DRAINAGE TOTALS	11	18.0	8,457.9	134.0
JEFFERSON	IRRIGATION	9	7.8	942.0	416.1
	OTHER	4	2.0	128.3	0.0
	DRAINAGE TOTALS	13	9.8	1,070.3	416.1
BIG HOLE	IRRIGATION	1	2.0	90.0	30.0
	STOCK	3	0.1	12.8	0.0
	POWER GENERATION	1	111.4	47,876.0	0.0
	OTHER	1	0.0	3.5	1.0
	DRAINAGE TOTALS	6	113.5	47,982.3	31.0
RUBY	IRRIGATION	4	13.4	2,005.6	1,170.0
	POWER GENERATION	1	12.5	4,667.0	0.0
	OTHER	2	0.1	18.0	0.0
	DRAINAGE TOTALS	7	26.0	6,690.6	1,170.0
BEAVERHEAD/ RED ROCK	IRRIGATION	1	0.6	105.0	50.0
	FISH AND WILDLIFE	3	1.3	13,631.9	0.0
	OTHER	3	1.2	93.0	2.0
	DRAINAGE TOTALS	7	3.1	13,829.9	52.0
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	1	0.1	20.0	0.0
	IRRIGATION	27	44.7	5,792.3	2,752.6
	STOCK	7	0.3	20.6	0.1
	FISH AND WILDLIFE	27	37.3	35,844.7	0.0
	POWER GENERATION	2	123.9	52,543.0	0.0
	OTHER	16	5.7	1,264.6	5.7
	GRAND TOTALS	80	212.0	95,485.2	2,758.4

Table A-4. Upper Missouri subbasin existing claims

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MISSOURI THREE FORKS TO HOLTER DAM	MUNICIPAL AND DOMESTIC	111	29,752.5	214,929.9	104.6
	IRRIGATION	1,273	9,494.0	996,859.0	373,283.1
	STOCK	1,034	3,439.0	25,163.2	0.0
	FISH AND WILDLIFE	45	105,052.8	7,920,859.6	0.0
	POWER GENERATION	17	76,902.6	15,780,306.0	0.0
	OTHER	219	158,709.0	4,406,830.7	5.0
	DRAINAGE TOTALS	2,699	383,349.9	29,344,948.4	373,392.7
MISSOURI HOLTER DAM TO BELT CREEK	MUNICIPAL AND DOMESTIC	125	195.6	74,835.5	169.5
	IRRIGATION	432	5,111.4	352,217.9	63,411.2
	STOCK	705	2,825.3	26,938.7	0.0
	FISH AND WILDLIFE	23	13,065.7	9,416,727.7	0.0
	OTHER	38	10,179.5	7,349,692.1	3.1
	DRAINAGE TOTALS	1,323	31,377.5	17,220,411.9	63,583.8
DEARBORN	MUNICIPAL AND DOMESTIC	17	0.5	50.0	27.3
	IRRIGATION	125	1,316.6	138,614.4	32,831.9
	STOCKWATER	348	0.1	0.0	0.0
	FISH AND WILDLIFE	4	0.0	0.0	0.0
	DRAINAGE TOTALS	494	1,317.2	138,664.4	32,859.2
SMITH	MUNICIPAL AND DOMESTIC	40	37.1	2,660.8	41.0
	IRRIGATION	622	53,400.2	636,467.7	175,762.5
	STOCK	668	996.0	41,658.7	0.0
	FISH AND WILDLIFE	39	3,620.2	1,118,620.8	0.0
	OTHER	28	656.2	27,253.4	0.0
	DRAINAGE TOTALS	1,397	58,709.7	1,826,661.4	175,803.5
SUN	MUNICIPAL AND DOMESTIC	73	6.3	1,941.8	17.9
	IRRIGATION	564	4,866.9	1,274,024.8	522,667.4
	STOCKWATER	926	0.0	0.0	0.0
	FISH AND WILDLIFE	38	50.0	14,600.0	0.0
	POWER GENERATION	2	6.5	3,673.8	0.0
	OTHER	9	3.5	213.6	4.2
	DRAINAGE TOTALS	1,612	4,933.2	1,294,454.0	522,689.5
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	365	29,987.1	292,603.5	360.4
	IRRIGATION	3,016	74,189.0	3,398,183.0	1,167,956.1
	STOCK	3,681	7,260.4	93,760.5	0.0
	FISH AND WILDLIFE	149	121,788.7	18,470,808.1	0.0
	POWER GENERATION	19	76,909.1	15,783,979.8	0.0
	OTHER	295	169,553.2	11,785,804.2	12.3
	GRAND TOTALS	7,525	479,687.5	49,825,139.1	1,168,328.8

Table A-5. Upper Missouri subbasin permits 1973 through June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MISSOURI THREE FORKS TO HOLTER DAM	MUNICIPAL AND DOMESTIC	5	0.1	7.0	0.0
	IRRIGATION	32	34.6	3,059.9	2,446.6
	STOCK	5	0.4	2.3	0.0
	FISH AND WILDLIFE	1	0.0	7.5	0.0
	POWER GENERATION	1	7,200.0	5,212,206.8	0.0
	OTHER	28	11.3	2,852.2	2.5
	DRAINAGE TOTALS	72	7,246.4	5,218,135.7	2,449.1
MISSOURI HOLTER DAM TO BELT CREEK	MUNICIPAL AND DOMESTIC	23	1.7	62.6	2.0
	IRRIGATION	88	78.5	15,317.8	5,466.3
	STOCK	6	0.0	42.1	0.0
	OTHER	34	3.4	265.4	26.3
	DRAINAGE TOTALS	151	83.6	15,687.9	5,494.6
DEARBORN	MUNICIPAL AND DOMESTIC	3	0.1	6.6	1.0
	IRRIGATION	7	2.9	378.2	177.5
	STOCK	2	0.0	19.8	0.0
	FISH AND WILDLIFE	4	0.0	1.8	0.0
	OTHER	2	0.1	5.6	3.0
	DRAINAGE TOTALS	18	3.1	412.0	181.5
SMITH	IRRIGATION	36	270.7	33,977.6	21,176.8
	STOCK	26	0.0	30.0	0.0
	FISH AND WILDLIFE	3	1.2	237.0	40.0
	OTHER	13	7.1	962.7	0.0
	DRAINAGE TOTALS	78	279.0	35,207.3	21,216.8
SUN	MUNICIPAL AND DOMESTIC	1	0.0	4.5	0.0
	IRRIGATION	73	79.5	6,376.1	2,864.8
	STOCK	6	0.3	61.7	23.1
	FISH AND WILDLIFE	4	2.3	1,616.5	0.0
	POWER GENERATION	1	1,440.0	1,042,264.8	0.0
	OTHER	13	3.8	152.8	16.6
	DRAINAGE TOTALS	98	1,525.9	1,050,476.4	2,904.5
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	32	2.0	80.7	3.0
	IRRIGATION	236	466.2	59,109.7	32,131.9
	STOCK	45	0.7	155.8	23.1
	FISH AND WILDLIFE	12	3.5	1,862.8	40.0
	POWER GENERATION	2	8,640.0	6,254,471.7	0.0
	OTHER	90	25.8	4,238.7	48.4
	GRAND TOTALS	417	9,138.2	6,319,919.4	32,246.4

Table A-6. Upper Missouri subbasin permits and applications post June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MISSOURI	MUNICIPAL AND DOMESTIC	1	0.0	1.0	0.0
THREE FORKS	FISH AND WILDLIFE	6	8.1	3,242.6	0.0
TO	OTHER	13	10.2	3,331.7	1.3
HOLTER DAM	DRAINAGE TOTALS	20	18.3	6,575.3	1.3
MISSOURI	MUNICIPAL AND DOMESTIC	1	0.2	1.9	0.2
HOLTER DAM	IRRIGATION	5	1.5	117.6	49.1
TO	STOCK	3	0.0	2.2	0.0
BELT	OTHER	5	0.3	30.4	6.7
CREEK	DRAINAGE TOTALS	14	2.0	152.1	56.0
SMITH	IRRIGATION	1	5.0	150.0	82.4
	STOCK	10	0.0	9.2	0.0
	OTHER	4	0.2	16.5	0.0
	DRAINAGE TOTALS	15	5.2	175.7	82.4
SUN	IRRIGATION	6	10.7	798.6	243.1
	STOCK	1	0.0	1.8	0.0
	FISH AND WILDLIFE	2	0.5	338.7	0.0
	DRAINAGE TOTALS	9	11.2	1,139.1	243.1
SUBASIN	MUNICIPAL AND DOMESTIC	2	0.2	2.9	0.2
TOTALS	IRRIGATION	12	17.3	1,066.2	374.6
	STOCK	14	0.0	13.2	0.0
	FISH AND WILDLIFE	8	8.5	3,581.3	0.0
	OTHER	22	10.7	3,378.6	8.0
	GRAND TOTALS	58	36.7	8,042.2	382.8

Table A-7. Marias/Teton subbasin existing claims

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MARIAS	MUNICIPAL AND DOMESTIC	163	917.9	17,420.8	452.5
	IRRIGATION	1,172	72,587.3	4,034,654.4	1,182,601.8
	STOCK	3,515	38,618.4	63,374.0	0.0
	FISH AND WILDLIFE	69	545.2	2,545,263.9	0.0
	OTHER	54	1,356.1	1,272,335.7	0.0
	DRAINAGE TOTALS	4,973	114,024.9	7,933,048.8	1,183,054.3
TETON	MUNICIPAL AND DOMESTIC	42	865.6	1,699.2	72.5
	IRRIGATION	519	20,042.5	1,110,466.6	300,173.2
	STOCK	814	54,432.1	151,064.1	0.0
	FISH AND WILDLIFE	22	313.9	111,897.0	0.0
	OTHER	8	248.7	164,525.4	0.0
	DRAINAGE TOTALS	1,405	75,902.8	1,539,652.3	300,245.7
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	205	1,783.5	19,120.1	524.9
	IRRIGATION	1,691	92,629.8	5,145,121.1	1,482,775.1
	STOCK	4,329	93,050.6	214,438.1	0.0
	FISH AND WILDLIFE	91	859.1	2,657,160.9	0.0
	OTHER	62	1604.8	1,436,861.1	0.1
	GRAND TOTALS	6,378	189,927.8	9,472,701.3	1,483,300.1

Table A-8. Marias/Teton subbasin permits 1973 through June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MARIAS	MUNICIPAL AND DOMESTIC	9	3.6	1,151.5	0.0
	IRRIGATION	73	225.5	22,349.8	11,625.8
	STOCK	91	2.5	489.8	0.0
	FISH AND WILDLIFE	14	0.1	220.1	0.0
	POWER GENERATION	1	900.0	636,000.0	0.0
	OTHER	7	3.9	681.8	21.0
	DRAINAGE TOTALS	195	1135.6	660,893.0	11,646.8
TETON	MUNICIPAL AND DOMESTIC	1	0.0	110.0	0.0
	IRRIGATION	17	37.8	4,085.3	2,231.0
	STOCK	7	2.0	126.8	0.0
	FISH AND WILDLIFE	1	0.0	1.3	0.0
	OTHER	1	0.7	15.0	0.0
	DRAINAGE TOTALS	27	40.5	4,338.4	2,231.0
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	10	3.6	1,261.5	0.0
	IRRIGATION	90	263.3	26,435.1	13,856.8
	STOCK	98	4.5	616.6	0.0
	FISH AND WILDLIFE	15	0.2	221.4	0.0
	POWER GENERATION	1	900.0	636,000.0	0.0
	OTHER	8	4.6	696.8	21.0
	GRAND TOTALS	222	1,176.2	665,231.4	13,877.8

Table A-9. Marias/Teton subbasin permits and applications post June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MARIAS	MUNICIPAL AND DOMESTIC	1	0.1	12.5	0.0
	IRRIGATION	5	5.8	926.0	490.5
	STOCK	5	0.1	52.8	8.0
	FISH AND WILDLIFE	1	0.0	49.0	0.0
	OTHER	1	0.0	67.7	0.0
	DRAINAGE TOTAL	13	6.0	1,108.0	498.5
SUBBASIN TOTALS	GRAND TOTALS	13	6.0	1,108.0	498.5

Table A-10. Middle Missouri subbasin existing claims

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MISSOURI BELT CREEK TO FORT PECK	MUNICIPAL AND DOMESTIC	31	59.6	322.1	51.6
	IRRIGATION	733	29,304.6	570,804.5	148,509.8
	STOCK	2,458	24,869.2	49,553.8	0.0
	FISH AND WILDLIFE	230	81.2	3,563.6	0.0
	POWER GENERATION	5	0.0	23.2	0.0
	OTHER	40	120.1	14,711.2	0.0
	DRAINAGE TOTALS	3,497	54,434.7	638,978.4	148,561.4
JUDITH	MUNICIPAL AND DOMESTIC	59	14.7	2,150.1	76.9
	IRRIGATION	998	171,566.9	399,977.5	153,453.8
	STOCK	1,991	22.1	48.2	0.0
	FISH AND WILDLIFE	44	69.1	49,995.0	0.0
	POWER GENERATION	7	254.1	184,405.7	0.0
	OTHER	64	172.1	53,840.1	0.5
	DRAINAGE TOTALS	3,163	172,099.0	690,416.6	153,531.2
MUSSELSHELL	MUNICIPAL AND DOMESTIC	39	2,257.4	107,920.2	121.9
	IRRIGATION	2,483	18,774.7	3,631,115.1	1,394,048.8
	STOCK	5,263	1,624.4	27,587.2	0.0
	FISH AND WILDLIFE	509	318.5	129,618.1	0.0
	POWER GENERATION	6	49,900.0	101,560.0	0.0
	OTHER	54	39.6	27,299.6	3.0
	DRAINAGE TOTALS	8,354	72,914.6	4,025,100.2	1,394,173.7
FORT PECK	MUNICIPAL AND DOMESTIC	75	6.7	3,165.0	65.8
	IRRIGATION	792	2,787.2	288,160.5	87,917.0
	STOCK	4,476	1,483.9	22,358.0	0.0
	FISH AND WILDLIFE	957	7.9	5,891.7	0.0
	POWER GENERATION	12	20,000.0	10,001,569.5	0.0
	OTHER	17	32.2	11,099.3	0.0
	DRAINAGE TOTALS	6,329	24,317.9	10,332,244.0	87,982.8
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	204	2,338.4	113,557.4	316.2
	IRRIGATION	5,006	222,433.5	4,890,057.7	1,783,929.4
	STOCK	14,188	27,999.7	99,547.3	0.0
	FISH AND WILDLIFE	1,740	476.7	189,068.4	0.0
	POWER GENERATION	30	70,154.1	10,287,558.4	0.0
	OTHER	175	364.1	106,950.2	3.5
	GRAND TOTALS	21,343	323,766.5	15,686,739.4	1,784,249.1

Table A-11. Middle Missouri subbasin permits 1973 through June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MISSOURI BELT CREEK TO FORT PECK	MUNICIPAL AND DOMESTIC	2	0.0	9.5	0.0
	IRRIGATION	14	44.7	2,998.2	1,399.6
	STOCK	108	15.9	499.4	0.0
	FISH AND WILDLIFE	17	0.1	172.4	0.0
	OTHER	3	1.0	150.2	1.0
	DRAINAGE TOTALS	144	61.7	3,829.7	1,400.6
JUDITH	MUNICIPAL AND DOMESTIC	1	1.6	250.0	0.0
	IRRIGATION	69	828.3	13,572.0	7,373.5
	STOCK	29	2.7	155.8	0.2
	FISH AND WILDLIFE	19	23.6	13,427.2	439.0
	POWER GENERATION	3	297.0	144,647.0	0.0
	OTHER	14	6.3	2,831.1	9.1
	DRAINAGE TOTALS	135	1,159.5	174,883.1	7,821.8
MUSSELSHELL	MUNICIPAL AND DOMESTIC	1	14.9	240.0	120.0
	IRRIGATION	126	497.3	23,778.0	13,510.2
	STOCK	158	7.6	1,824.2	386.0
	FISH AND WILDLIFE	41	0.0	644.2	992.0
	OTHER	5	2.2	312.5	30.0
	DRAINAGE TOTALS	331	522.0	26,798.9	15,038.2
FORT PECK	MUNICIPAL AND DOMESTIC	50	1.7	54.0	0.0
	IRRIGATION	86	392.5	21,827.1	10,168.5
	STOCK	259	50.0	1,685.4	5.5
	FISH AND WILDLIFE	53	4.0	860.8	232.0
	OTHER	16	0.1	68.6	1.0
	DRAINAGE TOTALS	464	448.3	24,495.9	10,407.0
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	54	18.2	553.5	120.0
	IRRIGATION	295	1,762.9	62,175.3	32,451.8
	STOCK	554	76.2	4,164.8	391.8
	FISH AND WILDLIFE	130	27.7	15,104.6	1,663.0
	POWER GENERATION	3	297.0	144,647.0	0.0
	OTHER	38	9.5	3,362.4	41.1
	GRAND TOTALS	1074	2,191.5	230,007.6	34,667.7

Table A-12. Middle Missouri subbasin permits and applications post June 30, 1985

DRAINAGE	PURPOSE	NUMBER	TOTAL RATE (cfs)	VOLUME (af)	LAND USED ON (acres)
MISSOURI BELT CREEK TO FORT PECK	IRRIGATION	3	6.7	365.0	188.0
	STOCK	33	0.0	416.0	0.0
	FISH AND WILDLIFE	9	0.0	324.9	0.0
	OTHER	1	0.0	24.6	0.0
	DRAINAGE TOTALS	46	6.7	1,130.5	188.0
JUDITH	IRRIGATION	5	4.8	726.0	622.7
	STOCK	9	0.0	27.2	0.0
	FISH AND WILDLIFE	16	75.5	42,580.0	3.2
	OTHER	5	2.0	313.5	0.5
	DRAINAGE TOTALS	35	82.3	43,646.7	626.4
MUSSELSHELL	MUNICIPAL AND DOMESTIC	1	0.2	24.0	0.0
	IRRIGATION	13	44.0	2,452.1	2,118.2
	STOCK	44	0.2	210.5	0.0
	FISH AND WILDLIFE	4	2.0	43.4	0.0
	OTHER	1	5.0	18.6	2.0
	DRAINAGE TOTALS	63	51.4	2,748.6	2,120.2
FORT PECK	MUNICIPAL AND DOMESTIC	15	0.6	28.8	0.0
	IRRIGATION	4	10.0	50.8	28.5
	STOCK	81	0.0	508.7	0.0
	FISH AND WILDLIFE	10	1.0	36.6	0.0
	OTHER	1	0.0	1.0	0.0
	DRAINAGE TOTALS	111	11.6	625.9	28.5
SUBBASIN TOTALS	MUNICIPAL AND DOMESTIC	16	0.8	52.8	0.0
	IRRIGATION	25	65.5	3,593.9	2,957.4
	STOCK	167	0.2	1,162.3	0.0
	FISH AND WILDLIFE	39	78.5	42,984.9	3.2
	OTHER	8	7.1	357.7	2.5
	GRAND TOTALS	255	152.1	48,151.6	2,963.1

APPENDIX B

METHODS USED BY DFWP TO DETERMINE THE AMOUNTS REQUESTED FOR INSTREAM FLOWS

METHODS USED TO DETERMINE INSTREAM FLOWS NEEDED TO PROTECT AQUATIC HABITAT

Several methods were used to determine the amount of water needed to protect aquatic habitat. A brief description of these methods is presented in the following sections.

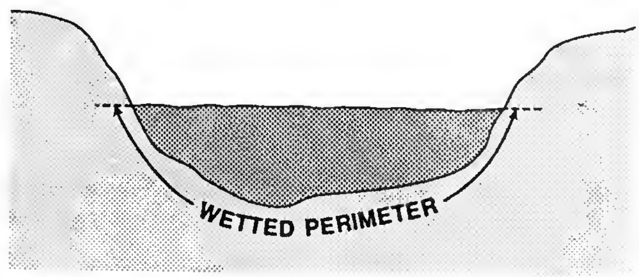
WETTED PERIMETER INFLECTION POINT METHOD

In determining the amount of instream flow necessary to protect habitat in riffle areas of most streams, DFWP and BLM used the Wetted Perimeter Inflection Point (WETP) method of calculation (DFWP 1989). This method is based on the assumptions that aquatic organisms making up the majority of food for gamefish are produced in riffle areas, and that food supply for the fish is a major factor in determining the number and weight of fish a stream can support. Riffles also are used by many gamefish for spawning and rearing of their young. Wetted perimeter is the linear distance along the bottom and sides of a stream that is in contact with water when the stream is viewed in cross section (see Figure B-1). As flows change, the wetted perimeter changes. If water is maintained in riffles, a substantial amount of stream width will extend near enough to streamside vegetation to provide shade and protection to pools and runs where adult fish reside.

The wetted perimeter of riffles usually changes more quickly than that of runs and pools when flows begin to recede. When streamflow is compared to the wetted perimeter, it can be seen that this rate of change is not constant (see Figure B-2). At high flows, the wetted perimeter of a riffle will not change much as flow changes. As flows decrease, the wetted perimeter decreases dramatically with small flow reductions. "Inflection points" occur where the wetted perimeter begins to decline rapidly with additional flow reductions.

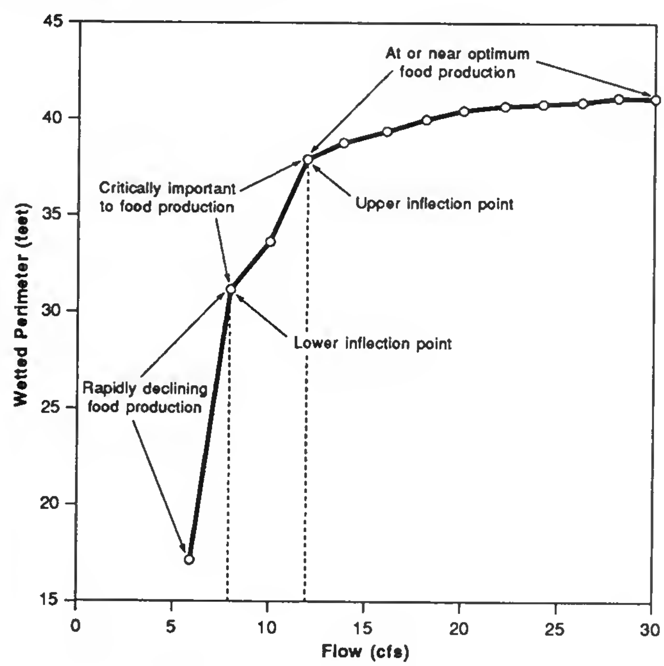
At high flows, the channel is full, and, except for floods, the stream has reached its maximum width. As flows are reduced, the wetted perimeter does not change much until the upper inflection point is reached. At the upper inflection point, water begins to drop below the vertical portion of stream banks, and the rate of change in wetted perimeter begins to increase. The point where the stream bottom (roughly horizontal portion of the channel) begins to be dewatered is the lower inflection point. More complex channel shapes may have several inflection points, while some channels may not have clearly defined inflection points. The upper and lower inflection points vary from one stream to another, and within a single stream the upper and lower inflection points will vary from one cross section to another. In determining how much water should be reserved to protect instream values, the applicants surveyed riffle cross sections in the field at several different flows. The wetted perimeter versus flow curves from

Figure B-1. The wetted perimeter in a channel cross section



Source: DFWP 1989

Figure B-2. An example of a relationship between wetted perimeter and flow



Source: DFWP 1989

several riffle cross sections were then averaged when determining inflection points.

According to DFWP,

> The Wetted Perimeter Inflection Point Method provides a range of flows (between and including the lower and upper inflection points) from which a single instream flow recommendation is selected. Flows below the lower inflection point are judged undesirable based on their probable impacts on food production, bank cover, and spawning and rearing habitats, while flows at and above the upper inflection point are considered to provide near optimal conditions for fish. The upper and lower inflection points are believed to bracket those flows needed to maintain high and low levels of aquatic habitat potential (DFWP 1986b).

Within the range of flows between the upper and lower inflection points, DFWP biologists used professional judgment to estimate the instream flow to be requested. They considered the flow needed to sustain particular fish species, quality of habitat, recreational use, potential for stream reclamation, and eventual increases in fish production.

FIXED PERCENTAGE METHOD

In this method, the WETP was used to find the high inflection point on some streams, and the flow rate corresponding to the high inflection point was expressed as a percentage of the average annual flow estimated for that stream. This was done on streams where average annual flows had been calculated by USFS and USGS. The percentages of the average annual flow at which the high inflection points occurred on these streams were averaged and applied to other streams in the same drainage (Table B-1). On each of the 27 streams shown in Table B-2, this average value was multiplied by the estimated average annual flow to arrive at the requested instream flow.

BASE FLOW APPROACH

The WETP method and fixed percentage approach do not work very well on spring creeks. On 17 high quality spring creeks (Table B-3) DFWP is requesting that the lowest average monthly flow for the year (the base flow), typically during the winter, be allocated for instream purposes year-round.

Table B-1. Upper inflection point flows expressed as percentages of average annual flows for selected streams in the Upper Missouri River basin

Subbasin Streams	Number of Stream Reaches	Upper Inflection Point % of Average Annual Flow	Range (% of Average Annual Flow)[a]
Beaverhead-Red Rock River tributaries	25	43	(16-70)
Big Hole River tributaries	21	32	(18-66)
Gallatin River tributaries (excludes East Gallatin River tributaries)	10	31	(25-39)
Jefferson River tributaries	7	36	(33-40)
Madison River tributaries	10	47	(29-61)
Ruby River tributaries	7	48	(37-54)
Upper Missouri River tributaries	7	34	(18-71)
Smith River tributaries	9	27	(16-39)
Musselshell River tributaries	6	44	(39-58)
Marias River tributaries	7	40	(24-68)

[a] Range excludes lowest and highest values to eliminate outliers that could distort the average percentage.
Source: DFWP 1989

Table B-2. Streams where DFWP used the fixed percentage method

Beaverhead-Red Rock subbasin
- Browns Canyon Creek
- Red Rock River (Reach #1)
- Reservoir Creek
- West Fork Dyce Creek

Big Hole subbasin
- Big Lake Creek
- Delano Creek
- Jacobson Creek
- Rock Creek
- Wyman Creek

Gallatin subbasin
- Hell Roaring Creek

Jefferson subbasin
- Halfway Creek

Madison subbasin
- Cougar Creek
- Duck Creek
- Elk River
- Moore Creek
- Red Canyon Creek
- Trapper Creek
- Watkins Creek

Ruby subbasin
- Coal Creek

Upper Missouri subbasin
- Deep Creek

Smith subbasin
- North Fork Deep Creek

Musselshell subbasin
- Collar Gulch Creek

Marias subbasin
- Badger Creek
- Birch Creek
- Cut Bank Creek
- North Fork Deep Creek
- South Fork Deep Creek

Source: DFWP 1989

Table B-3. Streams where DFWP used the base flow approach

Beaverhead-Red Rock drainage
Poindexter Slough

Gallatin drainage
Ben Hart Spring Creek
Thompson Spring Creek

Jefferson drainage
Willow Spring Creek

Madison drainage
Antelope Creek
Black Sand Spring Creek
Blaine Spring Creek
O'Dell Spring Creek
South Fork Madison River[b]

Ruby drainage
Warm Springs Creek

Belt Creek drainage
Big Otter Creek

Lake Helena-Hauser Reservoir
McGuire Creek[a]
Spokane Creek[a]
Silver Creek[a]

Sun drainage
North Fork Willow Creek

Teton drainage
McDonald Creek
Spring Creek

[a] Separate summer and winter base flows are being requested for the three spring creeks in the Helena Valley. Discharge in all three creeks is strongly influenced by irrigation practices in the valley. Flows increase significantly during the irrigation season. All three creeks provide important spawning habitat for large salmonids migrating out of the Hauser Reservoir-Lake Helena complex. The spawning runs depend upon the higher discharges that occur during the irrigation season. A base winter flow would not provide enough discharge to maintain these spawning runs.

Several flows were measured in each stream throughout the year to obtain information on the base flow characteristics of the stream and to identify the effects of irrigation. An average base summer flow was calculated using data collected between May and November, the period when spawning occurs in the streams. An average base winter flow was calculated for the remainder of the year. Both values were used to determine the flow requests for these streams.

[b] Although not a "classic" spring creek, the South Fork of the Madison River was included because subsurface inflows have a stabilizing influence on seasonal flows, causing the South Fork to more closely resemble a large spring-fed creek than a typical snow-fed mountain stream.

Source: DFWP 1989

RELATIONSHIPS BETWEEN FLOW RATE AND FISH

If sufficient information is available on how fish populations vary over the years, a relationship between flow rate and fish numbers or weight can sometimes be developed. Once this relationship is known, it is possible to select flow rates that will sustain a fish population. DFWP used this approach in the Gallatin River (reach 2), Madison River (reach 4), and Narrows Creek.

On the Missouri River (reaches 2-6), DFWP requested instream flows based on the seasonal biological needs of resident and migratory fish and nesting geese. The seasonal needs for fish included consideration of the amount of water necessary for successful paddlefish migration and rearing of young fish.

OTHER APPROACHES

DFWP also requested reservation of all remaining unappropriated water on four streams (Table B-4) to protect water quality and fisheries of the East Gallatin River. All remaining unappropriated water was requested on three tributaries (Table B-4) of the Madison River below Hebgen Dam to ensure adequate flow in the Madison when water is not being released from the dam. Lastly, on two intermittent tributaries of the Missouri River (Table B-4), one-half the average annual flow was requested during four months each year to protect a rainbow trout spawning run.

Table B-4. Streams where DFWP used other approaches to determine instream flow requests

Stream Reach	Request	Reason
East Gallatin River-Reach 1 Bridger Creek Rocky Creek Sourdough Creek	All remaining unappropriated water	To protect water quality in the East Gallatin River for fisheries purposes
Beaver Creek Cabin Creek West Fork Madison River	All remaining unappropriated water	To offset flow reductions due to storage at Hebgen Reservoir
Stickney Creek Wegner Creek	Mean annual flow for four months of the year	To allow rainbow trout from the Missouri to spawn in these intermittent streams

APPENDIX C

MISSOURI RIVER WATER AVAILABILITY MODEL AND MODEL RESULTS

MISSOURI RIVER WATER AVAILABILITY MODEL

DNRC developed a computer model to analyze physical and legal water availability in the Missouri basin and to assess the impacts that the proposed reservation requests could have on streamflows, reservoir levels, and hydropower production (DNRC 1990c). The model has three major components: (1) the streamflow component, (2) the irrigation component, and (3) the dam and reservoir operations component. A diagram of the model is presented in Figure C-1.

Seasonal streamflow patterns are calculated in the streamflow component on the basis of recorded flows and flow calculations generated by the reservoir and irrigation components of the model. The model calculates streamflows at 35 locations (Table C-1 and Map C-1).

The irrigation component of the model estimates monthly irrigation diversions, consumption, losses, and return flows for new and existing irrigation at each of the 35 locations. Information required for this component includes acres irrigated by each type of system used, crop water requirements, irrigation efficiencies, and surface water and groundwater return flows.

The dam and reservoir operations component of the model is used to compute storage, water surface elevations, releases, spills, diversions, and power generation on the basis of monthly inflows to the reservoirs. Dams included in the model are Hebgen, Madison, Canyon Ferry, Hauser, Holter, Black Eagle, Rainbow, Cochrane, Ryan, Morony, Tiber, and Fort Peck. Information required for this part of the model includes present goals for reservoir water elevations at different times of year, relationship between water elevation and reservoir volumes, turbine and electric generator capacities, and other relevant operations criteria.

Data for the model were obtained from several sources. Streamflows at each of the model's 35 measurement points were provided by USGS for the period 1929 to 1986 (USGS 1989). BUREC estimated irrigated acres and crop water requirements for this period (BUREC 1990). DNRC calculated groundwater return flows. Reservoir operation criteria were supplied by MPC for Hebgen, Madison, Holter, Hauser, Rainbow, Black Eagle, Cochrane, Ryan, and Morony dams (MPC 1989); by BUREC for Canyon Ferry and Tiber dams (BUREC 1989); and by the Army Corps of Engineers (COE) for Fort Peck Dam (COE 1989). Other information, such as irrigation system efficiencies and surface return flow factors, was developed by DNRC in cooperation with BUREC and SCS. The 1986 level of irrigation was used to simulate existing streamflows. DNRC selected 1986

Figure C-1. Missouri basin model schematic

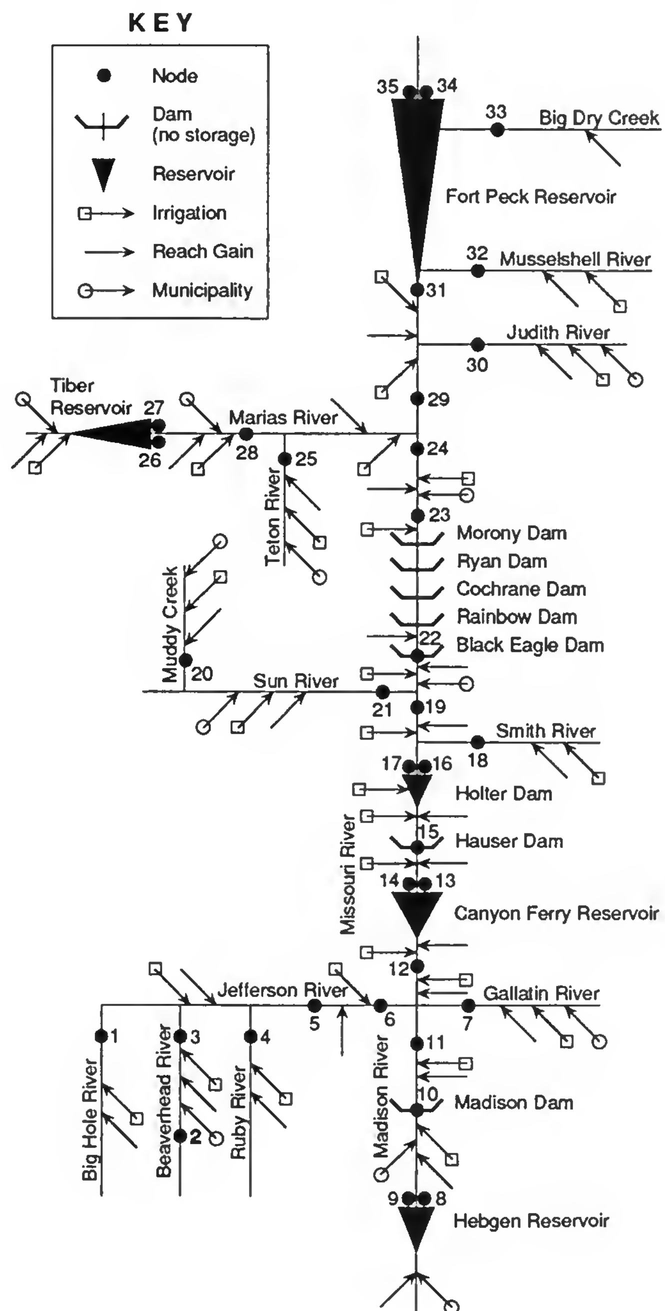


Table C-1. Location of Missouri basin model nodes

NODE	USGS GAUGE[a]	NODE LOCATION
1	255	Big Hole River - near Melrose
2	154	Beaverhead River - above Dillon
3	185	Beaverhead River - near Twin Bridges
4	230	Ruby River - near mouth
5	265	Jefferson River - near Twin Bridges
6	366.5	Jefferson River - near Three Forks
7	525	Gallatin River - near Logan
8	(MPC)	Madison River - inflow to Hebgen Reservoir
9	385	Madison River - outflow from Hebgen Reservoir
10	410	Madison River - below Ennis Lake
11	425	Madison River - near Three Forks
12	545	Missouri River - at Toston
13	(USBR)	Missouri River - inflow to Canyon Ferry Reservoir
14	(USBR)	Missouri River - outflow from Canyon Ferry Reservoir
15	(MPC)	Missouri River - outflow from Hauser Dam
16	(MPC)	Missouri River - inflow to Holter Lake
17	(MPC)	Missouri River - outflow from Holter Dam
18	775	Smith River - near Eden
19	782	Missouri River - near Ulm
20	885	Muddy Creek - at Vaughn
21	890	Sun River - near Vaughn
22	(MPC)	Missouri River - near Great Falls, at Black Eagle Dam
23	903	Missouri River - near Great Falls, below Morony Dam
24	908	Missouri River - at Fort Benton
25	1085	Teton River - near Loma (mouth)
26	(USBR)	Marias River - inflow to Tiber Reservoir
27	(USBR)	Marias River - outflow from Tiber Reservoir
28	1020.5	Marias River - near Loma, mouth
29	1095	Missouri River - at Virgelle
30	1135	Judith River - near mouth
31	1152	Missouri River - near Landusky
32	1305	Musselshell River - at Mosby
33	1310	Big Dry Creek - near mouth
34	ARMYCORP	Fort Peck inflows
35	1320	Fort Peck outflows

[a] USGS gauge codes are abbreviated
(MPC) = Historical records available from the Montana Power Company
(USBR) = Historical records available from the U.S. Bureau of Reclamation
ARMYCORP = Historical records available from the U.S. Army Corps of Engineers

because it is a recent year during which irrigated acreage approached maximum levels for the 1929 to 1986 period. DNRC considers this level of irrigation to best represent existing conditions in the basin. The first operation or "baseline" run of the model was used to estimate streamflows assuming a 1986 level of irrigation.

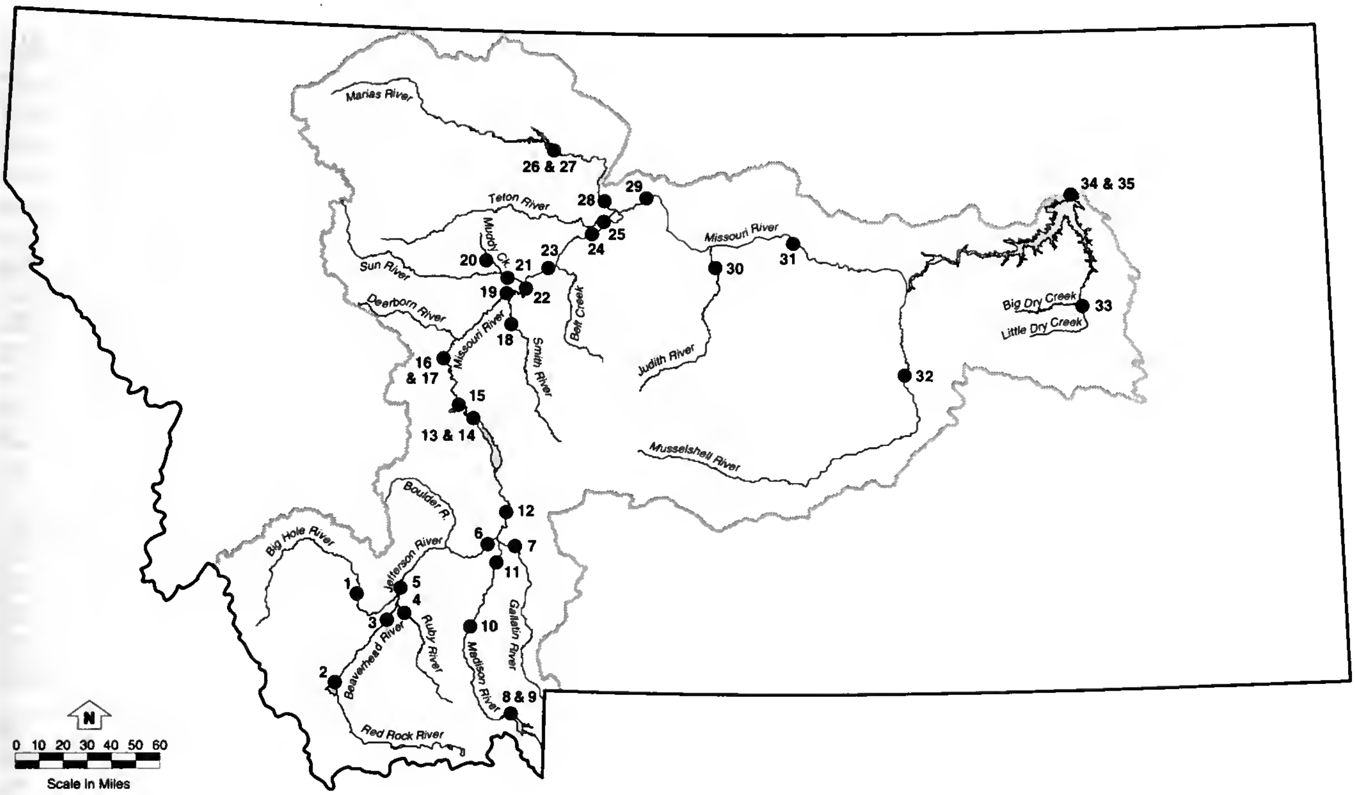
In this initial run, the model used recorded monthly average flows where they were available for the period 1929 to 1986. At measuring points where actual flow data were not available, the model was used to estimate them on the basis of data from surrounding locations. Irrigated acreage data and crop water requirements were used in the model to determine irrigation withdrawals, water consumption, and return flows for each of the 58 years at each of the 35 measuring points. Next, similar calculations were made using the 1986 irrigated acreage data instead of that for each year. The effects of the 1986 level of irrigation development were compared to those calculated for each year from 1929 to 1986. Any net monthly increases in flows at a location that resulted from 1986 irrigation levels were added to the measured or calculated flows at that location. Similarly, any net decreases in flow were subtracted. These calculated flows were then passed through the reservoir components of the model, where applicable, and readjusted to reflect planned reservoir operations. The results were estimates of flow for each year at each measuring point under 1986 levels of irrigation and current reservoir operations. Average and percentile flows, hydropower production, reservoir surface elevations, and storage summaries were calculated for each month. Information derived from this run served as the "baseline" case for comparison to model results from the three alternatives that include granting of reservations (Tables C-2 through C-6).

In Chapter Six, the model results are used to examine the effects of proposed new consumptive uses on streamflows, hydropower production, and reservoir operations. Project acreage, irrigation efficiencies, and return flow characteristics for new irrigation projects were included in the flow calculations at each water measuring location for each year. Similarly, information was entered to characterize the municipal requests and the proposed Virgelle interbasin diversion project, with reductions in flow associated with these reservations included in flow calculations when applicable. Monthly average and percentile flows were computed from the calculated flows at each node. These results were compared to those in the "baseline" run (Tables C-2 through C-6).

CLIMATE CHANGE

The prospect of a warmer climate poses a problem. The analysis in this EIS is based on the assumption that the climate and streamflows of the

Map C-1. Locations of nodes used in Missouri basin modeling



next 50 years will be similar to the 58-year record. If the climate of the Missouri River basin becomes significantly warmer and drier, then model results based on this assumption will not accurately reflect streamflows, crop requirements, and project impacts.

Present techniques for estimating water quantity and distribution in the Missouri River basin are based in part on a brief 58-year record of past streamflows. Conditions that affect water quantity and distribution, such as the length of the growing season, evaporation from reservoirs, and the water requirements of crops, may change beyond any fluctuation seen before in the historical record. Of particular concern is the possible warming of the earth's atmosphere, which would create a warmer global climate.

Over the last century, atmospheric concentrations of heat-trapping gases have increased rapidly due to widespread industrialization. Concentrations of carbon dioxide have increased by 25 percent and methane by 140 percent since the mid-1800s (EPA 1990, Neftez et al. 1990, Keeling et al. 1990, Stauffer et al. 1990, Khalil et al. 1990). The buildup of these gases could cause measurable, long-term warming of the climate during the next 40 to 80 years (EPA 1990, Intergovernmental Panel on Climate Change 1990, National Governors Association 1990). Debate continues over the magnitude and rate of warming and precisely how that warming will affect climate, environment, and economies. Most of the predictions published to date agree that the continental interior of North America should expect drying in response to increased global temperatures because of regional redistribution of precipitation (EPA 1990, Intergovernmental Panel on Climate Change 1990, Joyce et al. 1990). In the Missouri River basin, the effects could include reduced precipitation and snowpack, reduced streamflow, altered timing and rates of runoff, increased crop requirements and evaporative losses, and degraded surface and groundwater quality (EPA 1990, Joyce et al. 1990, Jacobs and Riebsane 1989).

Table C-2. Monthly streamflow percentile distributions (in cfs)

BASELINE CONDITIONS

MODEL NODE		% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG HOLE	1	Average	518	505	395	349	365	462	1537	3499	4228	1435	450	367	1176
RIVER NEAR		10	797	684	526	456	482	706	2428	5534	6588	2448	774	593	1835
MELROSE		20	673	617	457	420	415	530	2068	4549	5903	2024	668	514	1570
		50	469	474	355	347	341	399	1300	3156	4072	1409	450	324	1092
		80	333	360	287	254	289	337	890	2002	2497	666	204	207	694
		90	269	318	269	215	249	312	666	1870	1272	368	47	135	499
BEAVERHEAD	2	Average	261	285	250	206	207	227	273	398	581	456	424	305	323
RIVER		10	456	473	385	308	298	349	487	719	980	768	775	508	542
ABOVE DILLON		20	380	393	332	250	268	308	393	650	841	716	651	424	467
		50	217	280	245	206	209	215	214	345	537	497	390	243	300
		80	109	130	139	112	115	125	140	134	211	168	120	128	136
		90	87	96	94	84	99	102	96	86	123	15	17	70	81
BEAVERHEAD	3	Average	421	571	511	422	444	495	494	306	447	392	312	401	435
RIVER NEAR		10	728	792	678	560	560	626	820	611	915	726	548	640	684
TWIN		20	590	676	602	498	507	562	641	505	676	642	475	568	579
BRIDGES		50	410	559	496	416	437	494	447	206	348	386	308	386	408
		80	156	423	395	325	363	377	311	100	72	41	61	128	229
		90	106	347	338	263	325	348	263	51	0	0	0	91	178
MOUTH OF	4	Average	238	231	179	144	135	165	198	227	304	120	68	224	186
RUBY RIVER		10	301	295	238	180	168	226	331	405	609	330	195	305	299
		20	289	275	209	166	148	209	283	352	530	223	134	283	258
		50	242	232	167	138	130	149	176	208	236	89	40	221	169
		80	180	186	153	121	115	116	102	89	50	0	0	168	107
		90	152	165	147	118	109	109	92	40	0	0	0	154	90
JEFFERSON	5	Average	1283	1468	1242	1062	1101	1229	2325	3863	5201	1901	730	990	1866
RIVER NEAR		10	1869	1875	1518	1306	1328	1634	3333	6269	8071	3436	1336	1468	2787
TWIN BRIDGES		20	1622	1724	1395	1205	1235	1422	3034	5137	7176	2775	1079	1277	2423
		50	1270	1420	1210	1053	1071	1164	2030	3466	5108	1809	739	931	1773
		80	871	1203	1044	904	930	1010	1506	2311	2862	723	201	657	1185
		90	723	1086	977	804	845	921	1326	2020	1631	274	0	461	922
JEFFERSON	6	Average	1789	1895	1459	1319	1347	1649	2567	4332	6396	1914	796	1283	2229
RIVER NEAR		10	2597	2381	1933	1621	1846	2025	3498	6911	10700	3591	1694	1921	3393
THREE FORKS		20	2231	2173	1714	1516	1565	1886	3135	6017	9447	2678	1160	1643	2930
		50	1806	1893	1456	1334	1339	1638	2610	3970	6180	1748	727	1191	2158
		80	1146	1519	1137	1087	1034	1395	1688	2242	2913	523	172	866	1310
		90	966	1369	990	980	831	1317	1447	1811	2125	247	0	597	1057
GALLATIN	7	Average	748	813	746	680	709	820	1072	2082	3052	1394	692	637	1120
RIVER NEAR		10	1117	1096	927	861	854	1001	1427	3171	4733	2099	993	976	1605
LOGAN		20	991	991	864	799	809	926	1291	2687	4262	1877	888	851	1436
		50	812	814	763	689	719	810	996	2092	3066	1306	638	630	1111
		80	489	659	610	567	578	706	798	1233	1672	871	485	453	760
		90	340	458	507	480	496	619	703	1043	1305	652	387	220	601
MADISON	8	Average	863	880	799	776	758	754	930	1666	1926	993	804	826	998
RIVER INFLOWS		10	1060	1094	1012	917	899	945	1223	2278	3118	1467	1079	1115	1351
TO HEBGEN		20	949	956	925	894	846	862	1052	2021	2533	1325	1007	960	1194
RESERVOIR		50	808	786	791	758	772	754	881	1594	1814	938	758	762	952
		80	696	655	646	665	663	629	756	1241	1189	700	626	640	759
		90	634	609	585	611	600	583	716	1133	1002	616	579	590	688

Baseline conditions (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HEBGEN	9	Average	1462	1405	872	783	705	815	991	1053	1193	973	883	1102	1020
RESERVOIR		10	1955	1815	1106	923	837	1046	1373	1594	1684	1366	1273	1511	1374
OUTFLOWS TO		20	1688	1596	990	898	781	923	1138	1265	1389	1233	1226	1438	1214
MADISON RIVER		50	1308	1290	853	762	712	796	963	1037	1100	1023	851	998	974
		80	1204	1098	700	672	611	684	811	715	968	642	536	780	785
		90	1175	1044	638	611	564	565	710	703	913	413	472	735	712
MADISON RIVER	10	Average	2016	2079	1412	1280	1240	1429	1561	2130	2798	1773	1382	1579	1723
BELOW		10	2778	2708	1713	1565	1486	1715	2075	2972	3842	2382	1772	2054	2255
ENNIS LAKE		20	2374	2476	1631	1502	1438	1548	1781	2571	3638	1980	1763	2023	2060
		50	1877	1949	1381	1247	1270	1456	1600	1872	2606	1844	1408	1437	1662
		80	1712	1706	1208	1064	1063	1265	1328	1723	2098	1329	959	1261	1393
		90	1646	1557	1127	999	1020	1131	1107	1388	1659	932	791	1183	1212
MADSION RIVER	11	Average	2046	1897	1604	1313	1269	1432	1662	2204	2848	1679	1238	1495	1724
NEAR		10	2845	2446	2040	1577	1536	1731	2167	3033	4044	2523	1707	1952	2300
THREE FORKS		20	2446	2023	1959	1549	1489	1548	1853	2602	3756	1933	1647	1898	2059
		50	1924	1794	1609	1302	1302	1451	1646	2011	2731	1715	1227	1393	1675
		80	1739	1590	1265	1102	1045	1262	1432	1759	2020	1223	724	1189	1362
		90	1676	1525	1176	1033	969	1078	1160	1636	1690	823	602	1124	1208
MISSOURI	12	Average	4538	4769	3717	3263	3606	3967	5656	8681	11502	4719	2310	3240	4997
RIVER AT		10	5957	5896	4334	4031	4270	4786	7377	13161	17817	8133	3741	4715	7018
TOSTON		20	5531	5491	4160	3708	3959	4614	6839	11225	16582	6289	3065	4167	6303
		50	4240	4500	3680	3246	3566	3909	5242	8320	11468	4410	2251	3113	4829
		80	3382	3943	3245	2748	3240	3368	4290	5378	6627	2154	1280	2269	3494
		90	3120	3747	3041	2570	2935	2957	3835	4771	5536	1824	829	1846	3084
MISSOURI RIVER	13	Average	4665	4875	3742	3353	3702	4386	5751	8945	11561	4658	2193	3342	5098
INFLOWS TO		10	6560	6135	4592	4203	4585	5430	7494	14144	18762	7870	3736	4878	7366
CANYON FERRY		20	5790	5658	4218	3912	4206	5012	7076	11776	16385	7075	3136	4484	6561
RESERVOIR		50	4459	4695	3779	3389	3759	4301	5323	8320	11365	4175	2087	3159	4901
		80	3320	4139	3233	2725	3061	3723	4546	5570	5971	2095	1071	2313	3480
		90	3219	3572	2546	2322	2446	3440	3710	4547	4785	1377	692	1808	2872
CANYON FERRY	14	Average	4619	4668	4689	4172	4356	5360	5795	6205	6049	4959	3718	3812	4867
RESERVOIR		10	5511	5628	5846	5880	6000	8170	8810	9457	9214	7837	5460	5473	6941
OUTFLOWS TO		20	5373	5459	5577	5362	5591	6807	7399	8003	7750	6416	4603	4695	6086
MISSOURI RIVER		50	4831	4830	4835	4080	4172	5289	5777	6276	6067	4357	2928	3026	4706
		80	3901	3900	3905	2928	3242	2928	3142	3373	3287	2928	2928	3026	3291
		90	2928	3026	2928	2928	3242	2928	3026	2928	3026	2928	2928	3026	2987
HAUSER LAKE	15	Average	4624	4641	4717	4228	4353	5384	5772	6137	5969	4853	3661	3822	4847
OUTFLOWS TO		10	5513	5586	5847	5873	6001	8110	8829	9403	9144	7673	5416	5491	6907
MISSOURI RIVER		20	5412	5442	5587	5360	5635	6812	7371	7959	7673	6308	4550	4606	6060
		50	4819	4766	4863	4071	4218	5402	5803	6256	6028	4157	2937	3231	4712
		80	3784	3893	3907	2984	3257	3037	3264	3347	3071	2820	2832	2996	3266
		90	3068	3009	3028	2919	3169	2925	3011	2797	2926	2750	2791	2952	2946
MISSOURI	16	Average	4642	4637	4732	4286	4403	5452	5831	6258	6165	4782	3607	3867	4889
RIVER		10	5581	5648	5856	5956	6055	8056	8569	9522	9607	8012	5282	5623	6981
INFLOWS TO		20	5412	5451	5510	5427	5663	6835	7386	8384	8510	6168	4528	4695	6164
HOLTER LAKE		50	4877	4812	4904	4113	4101	5393	5905	6169	5884	3966	3100	3322	4712
		80	3798	3871	3918	3021	3299	3356	3791	3582	3878	2760	2733	2982	3416
		90	3060	2889	3101	2876	3077	2895	2952	2834	2856	2635	2641	2917	2894

Baseline conditions (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HOLTER LAKE	17	Average	4611	4638	4820	4376	4489	5435	5773	6114	6078	4819	3645	3873	4889
OUTFLOWS		10	5638	5728	5883	5999	6195	7850	8851	9532	9575	8118	5349	5559	7023
TO MISSOURI		20	5393	5453	5581	5564	5664	7028	7316	8336	8344	6130	4495	4752	6171
RIVER		50	4790	4815	4959	4209	4302	5364	5651	5816	5747	3964	3135	3428	4682
		80	3727	3823	3901	3048	3318	3270	3876	3638	3601	2902	2769	2997	3406
		90	2885	2922	3342	2814	3002	2779	3048	2611	2935	2758	2624	2817	2878
SMITH RIVER	18	Average	172	152	124	96	140	170	414	975	992	407	141	139	327
NEAR		10	330	260	241	151	243	265	699	1755	2233	884	283	258	633
EDEN		20	238	185	168	137	173	228	566	1481	1209	635	202	169	449
		50	140	129	105	93	124	156	339	793	796	302	124	106	267
		80	110	102	62	58	80	102	210	487	434	129	56	62	158
		90	87	87	23	38	63	83	179	345	304	60	24	50	112
MISSOURI	19	Average	5128	5185	5330	4955	5075	6176	7008	8862	8959	5913	3943	4206	5895
RIVER NEAR		10	6511	6571	6557	6511	7076	8699	10205	12818	13561	10001	5940	6238	8391
ULM		20	6087	5953	6047	6238	6284	7878	8857	11533	11557	7855	5003	5176	7372
		50	5096	5229	5377	4891	4856	6415	6843	8676	8470	4960	3372	3616	5650
		80	3975	4188	4442	3655	3630	3751	4704	6039	5298	3146	2781	3186	4066
		90	3349	3379	3591	3417	3299	3407	3465	4588	4482	2921	2661	2968	3461
MUDDY	20	Average	110	62	45	34	38	57	42	139	240	262	293	180	125
CREEK		10	145	73	57	49	58	100	57	210	343	369	390	254	176
AT		20	131	71	52	43	49	68	47	170	290	345	369	227	155
VAUGHN		50	109	63	44	34	35	39	35	128	226	255	306	183	122
		80	86	50	35	25	27	32	30	96	174	175	212	128	89
		90	77	48	30	21	22	29	28	67	154	141	175	104	75
SUN RIVER	21	Average	383	329	289	249	264	332	453	1567	2588	644	509	434	670
NEAR		10	503	451	433	342	388	662	920	2885	5038	1374	716	584	1191
VAUGHN		20	445	385	341	305	331	438	688	2397	3450	1125	670	541	926
		50	362	299	260	240	237	272	308	1481	1943	430	493	426	563
		80	282	244	199	171	187	200	184	535	1019	240	312	303	323
		90	234	203	181	131	148	159	152	320	736	42	224	239	231
MISSOURI	22	Average	5707	5499	5428	5037	5338	6610	7545	10398	11100	6586	4554	4689	6541
RIVER AT		10	7115	7187	6793	7054	7244	9504	10719	15787	17362	10834	6831	6610	9420
BLACK EAGLE		20	6683	6601	6385	6555	6740	8514	9389	13134	13913	9180	5912	5876	8240
DAM		50	5776	5416	5566	4893	5064	6568	7419	10031	10265	5789	3951	4230	6247
		80	4461	4437	4597	3668	3757	4023	5232	6660	6498	3506	3222	3583	4470
		90	3799	3455	3515	3204	3356	3636	3908	5738	4862	3097	3005	3323	3742
MISSOURI	23	Average	6057	5849	5778	5387	5688	6960	7895	10748	11450	6936	4904	5039	6891
RIVER BELOW		10	7465	7537	7143	7404	7594	9854	11069	16137	17712	11184	7181	6960	9770
MORONY		20	7033	6951	6735	6905	7090	8864	9739	13484	14263	9530	6262	6226	8590
DAM		50	6126	5766	5916	5243	5414	6918	7769	10381	10615	6139	4301	4580	6597
		80	4811	4787	4947	4018	4107	4373	5582	7010	6848	3856	3572	3933	4820
		90	4149	3805	3865	3554	3706	3986	4258	6088	5212	3447	3355	3673	4092
MISSOURI	24	Average	5913	5863	5826	5467	5802	7067	8103	11437	12451	7159	4905	5083	7090
RIVER AT		10	7417	7546	7262	7487	7720	10025	11261	17516	20204	11789	7173	7244	10220
FORT BENTON		20	7089	6814	6898	7055	7455	9398	10156	14562	15793	9405	6080	6235	8912
		50	5696	5765	5859	5376	5585	7128	7931	11042	11541	6104	4318	4629	6748
		80	4610	4783	4879	3993	4113	4412	5701	7446	7206	3814	3543	3905	4867
		90	3823	3783	3878	3548	3680	4001	4285	6243	5596	3544	3364	3620	4114

Baseline conditions (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
TETON RIVER	25	Average	51	230	169	140	205	509	478	852	1289	392	99	75	374
NEAR		10	229	705	411	310	548	1208	1149	2163	2385	1282	277	190	905
LOMA		20	53	205	251	229	322	676	839	1708	1638	640	41	105	559
		50	0	0	99	63	111	336	303	384	795	42	0	0	178
		80	0	0	0	0	0	111	0	0	54	0	0	0	14
		90	0	0	0	0	0	32	0	0	0	0	0	0	3
MARIAS RIVER	26	Average	358	355	282	249	354	743	1128	2618	3148	1019	348	278	907
INFLOWS		10	686	606	581	450	720	1514	2014	3851	5963	1950	664	582	1632
TO TIBER		20	487	465	380	319	423	962	1415	3554	4049	1405	504	461	1202
RESERVOIR		50	279	292	221	221	259	468	1058	2407	2487	856	316	215	757
		80	148	177	143	127	158	310	498	1804	1452	399	95	82	449
		90	119	153	123	105	108	254	440	1311	1229	149	0	0	333
TIBER	27	Average	961	767	766	766	768	554	707	815	903	1221	1221	1222	889
RESERVOIR		10	1524	1219	1219	1219	1219	839	1120	1454	1619	2025	2025	2025	1459
OUTFLOWS		20	1279	1023	1023	1023	1023	658	937	1033	1106	1570	1570	1570	1151
TO MARIAS		50	956	765	765	765	765	455	482	476	471	1132	1132	1132	775
RIVER		80	577	461	461	461	461	455	471	455	471	750	750	750	544
		90	423	339	339	339	339	455	471	455	471	513	513	513	431
MARIAS RIVER	28	Average	943	680	562	530	599	477	834	1091	1250	1168	1030	970	844
NEAR		10	1368	1116	982	981	1039	911	1495	1690	2840	2011	1855	1820	1509
LOMA		20	1223	906	839	830	894	705	1298	1547	1873	1841	1563	1339	1238
		50	932	694	625	491	613	399	708	1088	935	1079	1012	782	780
		80	590	362	160	184	237	198	363	509	464	596	472	426	380
		90	504	308	100	109	159	123	234	384	234	228	366	287	253
MISSOURI	29	Average	6678	6772	6557	6137	6605	8053	9185	13147	14748	8466	5791	5894	8170
RIVER AT		10	8471	8642	8404	8229	9055	11549	13015	18994	21943	13944	8422	8585	11605
VIRGELLE		20	8034	7931	7741	7966	8140	10380	11734	17325	18929	12074	7271	7287	10401
		50	6609	6742	6729	6062	6543	8165	8968	12577	13252	7323	5399	5162	7794
		80	5363	5610	5382	4265	4451	5025	6521	8930	8145	4414	3879	4356	5528
		90	4310	4712	4008	3716	4228	4535	4890	7340	6192	3986	3683	4127	4644
MOUTH	30	Average	380	393	391	412	478	514	502	538	583	549	440	409	466
OF JUDITH		10	574	598	602	639	705	752	835	812	914	799	712	657	717
RIVER		20	540	567	584	591	637	704	719	740	763	717	664	623	654
		50	313	331	276	365	510	536	451	528	557	520	372	268	419
		80	238	242	241	243	245	299	292	302	294	308	238	238	265
		90	235	241	239	241	241	244	257	252	264	266	226	236	245
MISSOURI	31	Average	7132	7320	7003	6529	7150	9308	10297	14168	16611	9583	6308	6379	8982
RIVER NEAR		10	8826	8825	8709	9164	10042	13577	15240	21918	25479	15545	9097	9202	12969
LANDUSKY		20	8663	8372	8558	8211	9351	11672	13498	17980	20582	13371	7952	7923	11345
		50	7045	7296	7169	6460	7171	9069	9669	13826	15554	8313	5875	5639	8591
		80	5757	6253	5681	4545	4762	5735	7220	9440	8989	4972	4100	4799	6021
		90	4525	5411	4118	3997	4411	5251	5511	7917	6781	4323	3907	4368	5043
MUSSELSHELL	32	Average	74	90	76	81	203	518	349	596	939	314	107	112	288
RIVER AT		10	159	162	162	168	449	1009	937	1542	2537	924	269	279	716
MOSBY		20	107	133	127	119	225	620	540	859	1623	452	194	159	430
		50	59	67	59	64	107	272	181	304	572	125	75	66	163
		80	4	18	17	18	36	110	60	80	121	32	13	14	44
		90	0	0	0	0	12	49	46	17	46	2	0	0	14

Baseline conditions (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG DRY	33	Average	5	3	2	3	56	317	90	32	80	54	19	17	56
CREEK NEAR		10	11	6	4	3	206	1042	79	90	264	122	29	13	156
MOUTH		20	5	4	2	1	64	625	47	21	124	46	13	5	80
		50	2	2	1	0	3	84	11	8	25	8	3	2	12
		80	0	1	0	0	0	9	4	3	3	1	1	0	2
		90	0	0	0	0	0	4	3	1	2	1	0	0	1
MISSOURI	34	Average	7132	6759	6204	6298	7910	13330	12039	14835	17984	10200	6582	6670	9662
RIVER INFLOWS		10	9758	9392	8189	9125	11672	20162	18200	22107	28932	17384	10218	10269	14617
TO FORT PECK		20	8554	8446	7481	8314	10345	15343	14615	19184	22557	13171	8459	8390	12072
RESERVOIR		50	6991	6391	6009	6122	7433	11503	10268	13742	16958	8893	6204	5783	8858
		80	5315	4871	4405	4401	5155	6410	7202	9082	10558	5390	3979	4406	5931
		90	4312	3795	3947	3559	4009	5489	5722	6458	7380	4612	3435	4140	4738
FORT PECK	35	Average	8196	9375	11873	8090	8008	6014	5569	5895	7252	11237	10145	9506	8430
RESERVOIR		10	10617	12232	15001	14205	13642	9669	8831	9535	12273	14005	12246	11940	12016
OUTFLOWS TO		20	9889	11378	14852	12553	12389	8828	8055	8686	11118	13183	11705	11073	11142
MISSOURI RIVER		50	8115	9295	12067	7165	7048	5007	4535	4829	5872	11213	9928	9396	7873
		80	6410	7293	9390	3582	3495	2928	3026	2928	3026	9251	8159	7631	5593
		90	5635	6384	8174	2928	3242	2928	3026	2928	3026	8254	7260	6926	5059

CONSUMPTIVE USE ALTERNATIVE

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG HOLE	1	Average	518	505	395	349	365	462	1537	3499	4228	1435	450	367	1176
RIVER NEAR		10	797	684	526	456	482	706	2428	5534	6588	2448	774	593	1835
MELROSE		20	673	617	457	420	415	530	2068	4549	5903	2024	668	514	1570
		50	469	474	355	347	341	399	1300	3156	4072	1409	450	324	1092
		80	333	360	287	254	289	337	890	2002	2497	666	204	207	694
		90	269	318	269	215	249	312	666	1870	1272	368	47	135	499
BEAVERHEAD	2	Average	261	285	250	206	207	227	273	398	581	456	424	305	323
RIVER		10	456	473	385	308	298	349	487	719	980	768	775	508	542
ABOVE DILLON		20	380	393	332	250	268	308	393	650	841	716	651	424	467
		50	217	280	245	206	209	215	214	345	537	497	390	243	300
		80	109	130	139	112	115	125	140	134	211	168	120	128	136
		90	87	96	94	84	99	102	96	86	123	15	17	70	81
BEAVERHEAD	3	Average	421	571	511	422	444	495	494	306	447	392	312	401	435
RIVER NEAR		10	728	792	678	560	560	626	820	611	915	726	548	640	684
TWIN		20	590	676	602	498	507	562	641	505	676	642	475	568	579
BRIDGES		50	410	559	496	416	437	494	447	206	348	386	308	386	408
		80	156	423	395	325	363	377	311	100	72	41	61	128	229
		90	106	347	338	263	325	348	263	51	0	0	0	91	178
MOUTH OF	4	Average	238	231	179	144	135	165	198	227	304	120	68	224	186
RUBY RIVER		10	301	295	238	180	168	226	331	405	609	330	195	305	299
		20	289	275	209	166	148	209	283	352	530	223	134	283	258
		50	242	232	167	138	130	149	176	208	236	89	40	221	169
		80	180	186	153	121	115	116	102	89	50	0	0	168	107
		90	152	165	147	118	109	109	92	40	0	0	0	154	90

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
JEFFERSON	5	Average	1283	1468	1242	1062	1101	1229	2325	3863	5201	1901	730	990	1866
RIVER NEAR		10	1869	1875	1518	1306	1328	1634	3333	6269	8071	3436	1336	1468	2787
TWIN BRIDGES		20	1622	1724	1395	1205	1235	1422	3034	5137	7176	2775	1079	1277	2423
		50	1270	1420	1210	1053	1071	1164	2030	3466	5108	1809	739	931	1773
		80	871	1203	1044	904	930	1010	1506	2311	2862	723	201	657	1185
		90	723	1086	977	804	845	921	1326	2020	1631	274	0	461	922
JEFFERSON	6	Average	1791	1896	1461	1320	1349	1649	2568	4331	6299	1690	612	1243	2184
RIVER NEAR		10	2599	2382	1934	1622	1847	2026	3498	6912	10567	3348	1451	1907	3341
THREE FORKS		20	2233	2175	1715	1517	1566	1887	3136	6017	9288	2419	946	1586	2874
		50	1807	1895	1457	1335	1340	1639	2611	3964	6103	1595	519	1147	2118
		80	1148	1521	1138	1088	1035	1396	1689	2241	2828	255	0	829	1264
		90	968	1371	991	981	832	1318	1448	1812	1983	0	0	572	1023
GALLATIN	7	Average	750	814	746	680	709	820	1072	2082	3048	1375	672	637	1117
RIVER NEAR		10	1119	1097	928	862	855	1001	1427	3170	4732	2079	967	977	1601
LOGAN		20	992	992	864	799	809	926	1291	2686	4260	1859	867	848	1433
		50	814	815	764	690	720	810	996	2092	3062	1288	616	632	1108
		80	490	661	611	568	579	706	798	1233	1669	848	464	450	756
		90	341	459	508	480	497	619	703	1043	1299	636	366	222	598
MADISON	8	Average	863	880	799	776	758	754	929	1666	1926	993	804	826	998
RIVER INFLOWS		10	1060	1094	1012	917	899	945	1223	2278	3118	1467	1079	1115	1351
TO HEBGEN		20	949	956	925	894	846	862	1052	2021	2533	1325	1007	960	1194
RESERVOIR		50	808	786	791	758	772	754	881	1594	1814	938	758	762	952
		80	696	655	646	665	663	629	756	1241	1189	700	626	640	759
		90	634	609	585	611	600	583	716	1133	1002	616	579	590	688
HEBGEN LAKE	9	Average	1462	1405	872	782	705	815	991	1053	1193	973	883	1102	1020
OUTFLOWS TO		10	1955	1815	1106	923	837	1046	1373	1594	1684	1366	1273	1511	1374
MADISON RIVER		20	1688	1596	990	898	780	923	1138	1265	1389	1233	1226	1437	1214
		50	1308	1290	853	762	712	796	963	1037	1100	1023	851	998	974
		80	1204	1098	700	672	611	684	811	715	968	642	536	780	785
		90	1175	1044	638	611	564	565	710	703	913	413	472	735	712
MADISON RIVER	10	Average	2016	2079	1412	1280	1240	1429	1561	2130	2797	1773	1381	1579	1723
BELOW		10	2778	2708	1713	1565	1486	1715	2075	2972	3842	2382	1772	2054	2255
ENNIS LAKE		20	2374	2476	1631	1502	1438	1548	1781	2571	3638	1980	1763	2023	2060
		50	1877	1949	1381	1247	1270	1456	1600	1872	2606	1844	1408	1437	1662
		80	1712	1706	1208	1064	1063	1265	1328	1723	2098	1329	959	1261	1393
		90	1646	1557	1127	999	1020	1131	1107	1388	1659	931	791	1183	1211
MADSION RIVER	11	Average	2045	1897	1604	1313	1269	1432	1662	2200	2808	1578	1154	1482	1704
NEAR		10	2844	2446	2040	1577	1536	1731	2167	3025	4014	2429	1622	1935	2281
THREE FORKS		20	2446	2023	1958	1549	1489	1548	1853	2602	3734	1847	1584	1880	2043
		50	1924	1794	1609	1302	1302	1451	1646	2006	2687	1620	1134	1381	1655
		80	1739	1590	1264	1102	1045	1262	1432	1752	1990	1127	645	1165	1343
		90	1676	1525	1176	1033	969	1078	1160	1636	1629	730	513	1103	1186
MISSOURI	12	Average	4542	4771	3719	3264	3608	3968	5657	8676	11361	4376	2022	3186	4929
RIVER AT		10	5961	5900	4336	4032	4271	4787	7378	13160	17754	7777	3372	4681	6951
TOSTON		20	5535	5493	4162	3709	3960	4615	6840	11214	16348	5963	2746	4139	6227
		50	4244	4503	3682	3248	3567	3911	5243	8321	11317	4056	1956	3077	4760
		80	3386	3946	3247	2750	3242	3369	4291	5364	6531	1820	1045	2209	3433
		90	3123	3749	3043	2572	2937	2958	3836	4771	5314	1468	601	1780	3013

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
MISSOURI RIVER	13	Average	4668	4879	3745	3356	3704	4387	5752	8930	11331	4098	1743	3237	4986
INFLOWS TO		10	6565	6139	4595	4205	4587	5432	7495	14142	18607	7263	3223	4823	7256
CANYON FERRY		20	5795	5662	4221	3914	4208	5014	7076	11774	16174	6458	2669	4433	6450
RESERVOIR		50	4458	4699	3783	3392	3761	4303	5325	8317	11127	3567	1670	2995	4783
		80	3325	4143	3236	2727	3063	3725	4547	5562	5581	1406	600	2104	3335
		90	3224	3576	2549	2324	2448	3442	3712	4527	4571	802	208	1599	2748
CANYON FERRY	14	Average	4519	4603	4606	4127	4270	5310	5741	6141	5990	4611	3480	3654	4754
RESERVOIR		10	5498	5630	5840	5814	5950	8146	8785	9429	9187	7231	5178	5233	6827
OUTFLOWS TO		20	5364	5461	5581	5317	5430	6754	7341	7939	7689	5882	4281	4508	5962
MISSOURI RIVER		50	4766	4764	4770	4020	3985	5223	5707	6197	5995	3845	2928	3026	4602
		80	2928	3602	3606	2928	3242	2928	3026	2928	3026	2928	2928	3026	3091
		90	2928	3026	2928	2928	3242	2928	3026	2928	3026	2928	2928	3026	2987
HAUSER LAKE	15	Average	4524	4575	4634	4183	4266	5334	5718	6072	5910	4505	3422	3664	4734
OUTFLOWS TO		10	5504	5647	5842	5853	5951	8089	8787	9374	9103	7066	5133	5208	6796
MISSOURI RIVER		20	5404	5443	5591	5315	5537	6759	7437	7897	7612	5789	4205	4477	5955
		50	4710	4723	4863	4011	4109	5320	5756	6134	5947	3599	2908	3136	4601
		80	3112	3595	3609	2984	3234	3022	3213	3074	3056	2797	2803	2965	3122
		90	2932	2898	3015	2885	2967	2925	3011	2797	2899	2748	2736	2912	2894
MISSOURI	16	Average	4542	4572	4649	4241	4317	5402	5777	6194	6105	4432	3368	3709	4776
RIVER		10	5559	5638	5834	5920	6011	8025	8477	9471	9574	7395	4999	5327	6852
INFLOWS TO		20	5417	5452	5504	5382	5576	6781	7328	8263	8473	5621	4122	4550	6039
HOLTER LAKE		50	4829	4767	4870	4078	3962	5326	5798	6123	5813	3479	2878	3175	4592
		80	3190	3570	3637	3021	3299	3266	3791	3444	3768	2691	2687	2959	3277
		90	2973	2864	3040	2838	2811	2895	2952	2834	2798	2613	2550	2904	2839
HOLTER LAKE	17	Average	4512	4573	4737	4331	4402	5386	5719	6049	6018	4469	3406	3714	4776
OUTFLOWS		10	5587	5732	5799	5975	6159	7682	8759	9488	9505	7501	5066	5276	6877
TO MISSOURI		20	5427	5443	5549	5524	5587	6947	7225	8299	8297	5583	4123	4526	6044
RIVER		50	4680	4807	4962	4095	4263	5318	5564	5762	5715	3521	2967	3286	4578
		80	3244	3651	3659	3039	3312	3270	3835	3258	3526	2849	2718	2934	3275
		90	2885	2801	3148	2814	3002	2779	3048	2610	2934	2641	2518	2739	2827
SMITH RIVER	18	Average	173	153	124	97	140	170	414	974	983	384	123	130	322
NEAR		10	330	260	241	151	243	265	699	1755	2229	866	264	249	629
EDEN		20	237	186	168	137	173	228	566	1480	1199	611	181	161	444
		50	140	130	105	93	125	156	339	792	786	283	109	101	263
		80	111	102	63	58	80	102	210	487	425	110	34	55	153
		90	88	87	23	38	63	83	179	343	289	36	2	43	106
MISSOURI	19	Average	5030	5122	5248	4912	4990	6128	6954	8795	8878	5512	3662	4032	5772
RIVER NEAR		10	6513	6609	6550	6445	7067	8679	10163	12770	13484	9338	5638	5971	8269
ULM		20	6091	5954	6043	6169	6206	7766	8863	11431	11486	7209	4588	4903	7226
		50	5036	5151	5328	4860	4805	6347	6734	8565	8295	4494	3211	3543	5531
		80	3703	4029	4192	3622	3578	3618	4708	5979	5161	3050	2664	3107	3951
		90	3248	3381	3536	3419	3265	3408	3466	4585	4455	2758	2530	2901	3413
MUDDY	20	Average	110	62	45	34	38	57	42	139	237	253	286	177	123
CREEK		10	145	73	57	49	58	100	57	210	342	359	384	248	174
AT		20	131	71	52	43	49	68	47	169	286	336	360	223	153
VAUGHN		50	109	63	43	34	35	39	35	127	222	246	300	182	120
		80	86	50	35	25	27	32	30	96	170	165	205	125	87
		90	77	48	30	21	22	29	28	66	150	134	167	102	73

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
SUN RIVER	21	Average	384	329	289	249	264	332	453	1559	2549	566	462	423	655
NEAR		10	503	451	433	342	388	662	920	2881	5020	1322	679	576	1181
VAUGHN		20	445	385	341	305	331	438	688	2396	3421	1015	623	532	910
		50	362	299	259	240	237	272	308	1468	1914	345	447	412	547
		80	282	244	199	171	187	200	183	522	963	137	265	288	303
		90	234	203	181	131	148	159	152	307	687	0	158	239	217
MISSOURI	22	Average	5609	5436	5346	4994	5253	6562	7491	10324	10979	6107	4226	4503	6402
RIVER AT		10	7103	7237	6798	6990	7283	9384	10598	15728	17083	10098	6403	6260	9247
BLACK EAGLE		20	6686	6576	6379	6525	6678	8436	9396	13030	13791	8482	5314	5754	8087
DAM		50	5723	5435	5474	4872	4991	6508	7307	9911	10062	5010	3697	3999	6082
		80	4375	4301	4306	3568	3710	3932	5236	6625	6346	3246	3124	3478	4354
		90	3585	3458	3477	3207	3289	3637	3909	5727	4776	2925	2760	3237	3665
MISSOURI	23	Average	5959	5786	5696	5344	5603	6912	7841	10674	11329	6457	4576	4853	6752
RIVER BELOW		10	7453	7587	7148	7340	7633	9734	10948	16078	17433	10448	6753	6610	9597
MORONY		20	7036	6926	6729	6875	7028	8786	9746	13380	14141	8832	5664	6104	8437
DAM		50	6073	5785	5824	5222	5341	6858	7657	10261	10412	5360	4047	4349	6432
		80	4725	4651	4655	3918	4060	4282	5586	6975	6696	3595	3474	3828	4704
		90	3935	3808	3827	3557	3639	3987	4259	6077	5126	3275	3110	3587	4015
MISSOURI	24	Average	5815	5800	5745	5424	5716	7018	8049	11347	12266	6555	4497	4865	6925
RIVER AT		10	7423	7645	7267	7486	7736	9986	11221	17449	19868	10818	6723	6873	10041
FORT BENTON		20	7092	6815	6902	7011	7380	9349	10135	14487	15590	8658	5510	6011	8745
		50	5649	5769	5785	5373	5398	7057	7850	10889	11285	5343	4013	4356	6564
		80	4316	4645	4661	3902	4096	4356	5705	7377	6979	3508	3367	3758	4723
		90	3710	3785	3808	3551	3676	4002	4286	6213	5320	3210	2975	3512	4004
TETON RIVER	25	Average	51	231	170	140	205	509	478	847	1259	349	87	69	366
NEAR		10	231	707	411	310	549	1208	1150	2163	2376	1207	208	192	893
LOMA		20	53	207	252	230	322	677	839	1695	1613	548	3	73	543
		50	0	0	100	64	111	336	303	383	767	0	0	0	172
		80	0	0	0	0	0	111	0	0	0	0	0	0	9
		90	0	0	0	0	0	32	0	0	0	0	0	0	3
MARIAS RIVER	26	Average	357	355	282	249	354	743	1128	2615	3135	994	334	272	902
INFLOWS		10	683	606	581	450	720	1514	2014	3851	5957	1936	650	573	1628
TO TIBER		20	487	465	380	319	423	962	1415	3554	4038	1376	482	450	1196
RESERVOIR		50	278	292	221	221	259	468	1058	2405	2472	830	304	204	751
		80	147	177	143	127	158	310	498	1804	1430	382	74	72	443
		90	119	153	123	105	108	254	440	1306	1206	118	0	0	328
TIBER	27	Average	962	767	766	766	768	553	705	812	909	1211	1211	1212	887
RESERVOIR		10	1523	1218	1218	1218	1218	838	1119	1447	1617	2014	2014	2014	1455
OUTFLOWS		20	1281	1025	1025	1025	1025	655	933	1030	1102	1560	1560	1560	1148
TO MARIAS		50	957	765	765	765	765	455	481	472	471	1124	1124	1124	772
RIVER		80	574	459	459	459	459	455	471	455	471	737	737	737	539
		90	422	338	338	338	338	455	471	455	471	500	500	500	427
MARIAS RIVER	28	Average	942	680	562	530	600	475	831	1055	1138	916	854	891	789
NEAR		10	1371	1117	982	981	1040	908	1495	1654	2736	1818	1712	1781	1466
LOMA		20	1224	906	840	831	895	702	1294	1501	1701	1570	1390	1231	1174
		50	934	694	625	492	613	399	703	1064	806	785	785	698	717
		80	586	361	159	184	236	198	357	504	252	310	294	351	316
		90	503	307	99	108	158	123	232	340	47	0	169	186	189

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
MISSOURI	29	Average	6579	6710	6476	6094	6520	8003	9127	12981	14301	7326	5035	5524	7890
RIVER AT		10	8478	8658	8392	8163	9084	11508	12895	18892	21442	12433	7711	8178	11319
VIRGELLE		20	8039	7908	7745	7940	8092	10185	11669	17199	18379	10510	6590	6760	10085
		50	6478	6715	6656	6036	6395	8094	8902	12416	12772	5926	4628	4875	7491
		80	4715	5421	5221	4268	4380	5017	6522	8716	7640	3359	3312	3988	5213
		90	4245	4715	3901	3718	3936	4536	4890	7169	5560	3135	2799	3786	4366
MOUTH	30	Average	384	393	391	412	478	514	502	534	559	470	374	395	451
OF JUDITH		10	577	599	602	639	705	752	835	804	902	726	648	647	703
RIVER		20	544	568	584	591	637	704	719	740	741	640	595	618	640
		50	317	331	276	365	510	536	451	528	550	445	325	265	408
		80	241	243	241	243	245	299	292	293	267	226	168	218	248
		90	238	242	239	241	241	244	257	244	232	182	151	213	227
MISSOURI	31	Average	7035	7259	6922	6486	7065	9259	10239	13997	16138	8360	5483	5994	8686
RIVER NEAR		10	8819	8837	8716	9124	10016	13489	15153	21616	24975	13879	8322	8817	12647
LANDUSKY		20	8663	8377	8393	8147	9325	11554	13381	17862	20202	11988	7024	7581	11042
		50	6901	7303	7154	6418	7092	9021	9595	13707	14850	6944	5137	5367	8291
		80	5204	6065	5516	4548	4712	5736	7158	9179	8448	3784	3456	4368	5681
		90	4530	5223	4120	3915	4318	5139	5511	7742	5973	3288	3097	3865	4727
MUSSELSHELL	32	Average	74	90	76	81	203	518	349	596	939	314	107	112	288
RIVER AT		10	159	162	162	168	449	1009	937	1542	2537	924	269	279	716
MOSBY		20	107	133	127	119	225	620	540	859	1623	452	194	159	430
		50	59	67	59	64	107	272	181	304	572	125	75	66	163
		80	4	18	17	18	36	110	60	80	121	32	13	14	44
		90	0	0	0	0	12	49	46	17	46	2	0	0	14
BIG DRY	33	Average	5	3	2	3	56	317	90	32	80	54	19	17	56
CREEK		10	11	6	4	3	206	1042	79	90	264	122	29	13	156
NEAR MOUTH		20	5	4	2	1	64	625	47	21	124	46	13	5	80
		50	2	2	1	0	3	84	11	8	25	8	3	2	12
		80	0	1	0	0	0	9	4	3	3	1	1	0	2
		90	0	0	0	0	0	4	3	1	2	1	0	0	1
MISSOURI	34	Average	7035	6698	6124	6255	7825	13281	11982	14664	17511	8976	5757	6285	9366
RIVER INFLOWS		10	9761	9385	8197	9135	11714	20133	18103	21990	28426	16091	9300	9755	14332
TO FORT PECK		20	8630	8476	7484	8277	10293	15249	14565	18990	22184	11973	7483	7846	11788
RESERVOIR		50	6966	6305	6059	6019	7394	11485	10196	13520	16312	7580	5263	5363	8539
		80	5139	4874	4171	4350	5091	6409	7183	9022	10029	4355	3269	4137	5669
		90	4309	3655	3802	3562	3954	5478	5711	6373	6597	3530	2546	3632	4429
FORT PECK	35	Average	7924	9057	11500	7841	7757	5829	5407	5710	6999	10892	9802	9145	8155
RESERVOIR		10	10382	11956	15001	14055	13526	9476	8653	9340	12008	13716	12100	11660	11823
OUTFLOWS TO		20	9587	11023	14378	12186	12026	8568	7816	8423	10761	12857	11411	10764	10816
MISSOURI RIVER		50	7833	8964	11624	6783	6668	4736	4285	4555	5499	10896	9642	9085	7548
		80	6128	6962	8947	3158	3242	2928	3026	2928	3026	9014	7945	7389	5391
		90	5295	5984	7639	2928	3242	2928	3026	2928	3026	7907	6947	6604	4871

COMBINATION ALTERNATIVE

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG HOLE	1	Average	518	505	395	349	365	462	1537	3499	4228	1435	450	367	1176
RIVER NEAR		10	797	684	526	456	482	706	2428	5534	6588	2448	774	593	1835
MELROSE		20	673	617	457	420	415	530	2068	4549	5903	2024	668	514	1570
		50	469	474	355	347	341	399	1300	3156	4072	1409	450	324	1092
		80	333	360	287	254	289	337	890	2002	2497	666	204	207	694
		90	269	318	269	215	249	312	666	1870	1272	368	47	135	499
BEAVERHEAD	2	Average	261	285	250	206	207	227	273	398	581	456	424	305	323
RIVER		10	456	473	385	308	298	349	487	719	980	768	775	508	542
ABOVE DILLON		20	380	393	332	250	268	308	393	650	841	716	651	424	467
		50	217	280	245	206	209	215	214	345	537	497	390	243	300
		80	109	130	139	112	115	125	140	134	211	168	120	128	136
		90	87	96	94	84	99	102	96	86	123	15	17	70	81
BEAVERHEAD	3	Average	421	571	511	422	444	495	494	306	447	392	312	401	435
RIVER NEAR		10	728	792	678	560	560	626	820	611	915	726	548	640	684
TWIN		20	590	676	602	498	507	562	641	505	676	642	475	568	579
BRIDGES		50	410	559	496	416	437	494	447	206	348	386	308	386	408
		80	156	423	395	325	363	377	311	100	72	41	61	128	229
		90	106	347	338	263	325	348	263	51	0	0	0	91	178
MOUTH OF	4	Average	238	231	179	144	135	165	198	227	304	120	68	224	186
RUBY RIVER		10	301	295	238	180	168	226	331	405	609	330	195	305	299
		20	289	275	209	166	148	209	283	352	530	223	134	283	258
		50	242	232	167	138	130	149	176	208	236	89	40	221	169
		80	180	186	153	121	115	116	102	89	50	0	0	168	107
		90	152	165	147	118	109	109	92	40	0	0	0	154	90
JEFFERSON	5	Average	1283	1468	1242	1062	1101	1229	2325	3863	5201	1901	730	990	1866
RIVER NEAR		10	1869	1875	1518	1306	1328	1634	3333	6269	8071	3436	1336	1468	2787
TWIN BRIDGES		20	1622	1724	1395	1205	1235	1422	3034	5137	7176	2775	1079	1277	2423
		50	1270	1420	1210	1053	1071	1164	2030	3466	5108	1809	739	931	1773
		80	871	1203	1044	904	930	1010	1506	2311	2862	723	201	657	1185
		90	723	1086	977	804	845	921	1326	2020	1631	274	0	461	922
JEFFERSON	6	Average	1790	1895	1460	1319	1348	1649	2568	4332	6374	1861	752	1274	2218
RIVER NEAR		10	2598	2381	1933	1622	1846	2025	3498	6911	10670	3535	1638	1918	3381
THREE FORKS		20	2232	2174	1714	1516	1565	1886	3135	6017	9413	2619	1113	1630	2918
		50	1806	1894	1456	1334	1339	1638	2611	3969	6163	1719	675	1187	2149
		80	1147	1520	1138	1087	1034	1396	1688	2242	2894	461	119	859	1299
		90	967	1370	990	980	831	1317	1447	1811	2094	187	0	586	1048
GALLATIN	7	Average	749	814	746	680	709	820	1072	2082	3049	1381	679	637	1118
RIVER NEAR		10	1118	1097	927	862	854	1001	1427	3170	4732	2085	976	977	1602
LOGAN		20	992	992	864	799	809	926	1291	2686	4261	1865	875	849	1434
		50	813	814	763	689	719	810	996	2092	3063	1295	624	631	1109
		80	490	660	611	567	579	706	798	1233	1670	856	471	450	758
		90	341	459	508	480	496	619	703	1043	1300	642	373	221	599
MADISON	8	Average	863	880	799	776	758	754	929	1666	1926	993	804	826	998
RIVER INFLOWS		10	1060	1094	1012	917	899	945	1223	2278	3118	1467	1079	1115	1351
TO HEBGEN		20	949	956	925	894	846	862	1052	2021	2533	1325	1007	960	1194
RESERVOIR		50	808	786	791	758	772	754	881	1594	1814	938	758	762	952
		80	696	655	646	665	663	629	756	1241	1189	700	626	640	759
		90	634	609	585	611	600	583	716	1133	1002	616	579	590	688

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HEBGEN	9	Average	1462	1405	872	782	705	815	991	1053	1193	973	883	1102	1020
RESERVOIR		10	1955	1815	1106	923	837	1046	1373	1594	1684	1366	1273	1511	1374
OUTFLOWS TO		20	1688	1596	990	898	780	923	1138	1265	1389	1233	1226	1437	1214
MADISON RIVER		50	1308	1290	853	762	712	796	963	1037	1100	1023	851	998	974
		80	1204	1098	700	672	611	684	811	715	968	642	536	780	785
		90	1175	1044	638	611	564	565	710	703	913	413	472	735	712
MADISON RIVER	10	Average	2016	2079	1412	1280	1240	1429	1561	2130	2797	1773	1381	1579	1723
BELOW		10	2778	2708	1713	1565	1486	1715	2075	2972	3842	2382	1772	2054	2255
ENNIS LAKE		20	2374	2476	1631	1502	1438	1548	1781	2571	3638	1980	1763	2023	2060
		50	1877	1949	1381	1247	1270	1456	1600	1872	2606	1844	1408	1437	1662
		80	1712	1706	1208	1064	1063	1265	1328	1723	2098	1329	959	1261	1393
		90	1646	1557	1127	999	1020	1131	1107	1388	1659	931	791	1183	1211
MADSION RIVER	11	Average	2045	1897	1604	1313	1269	1432	1662	2200	2808	1578	1154	1482	1704
NEAR		10	2844	2446	2040	1577	1536	1731	2167	3025	4014	2429	1622	1935	2281
THREE FORKS		20	2446	2023	1958	1549	1489	1548	1853	2602	3734	1847	1584	1880	2043
		50	1924	1794	1609	1302	1302	1451	1646	2006	2687	1620	1134	1381	1655
		80	1739	1590	1264	1102	1045	1262	1432	1752	1990	1127	645	1165	1343
		90	1676	1525	1176	1033	969	1078	1160	1636	1629	730	513	1103	1186
MISSOURI	12	Average	4540	4770	3718	3263	3607	3968	5656	8676	11437	4550	2169	3217	4964
RIVER AT		10	5959	5898	4335	4031	4271	4786	7377	13160	17788	7966	3569	4703	6987
TOSTON		20	5533	5492	4161	3708	3959	4615	6840	11219	16476	6139	2907	4149	6267
		50	4242	4502	3681	3247	3567	3910	5242	8320	11402	4247	2126	3097	4799
		80	3384	3944	3246	2749	3241	3369	4290	5364	6576	1988	1165	2262	3465
		90	3121	3748	3042	2571	2936	2957	3836	4770	5430	1613	733	1822	3048
MISSOURI RIVER	13	Average	4666	4877	3743	3355	3703	4386	5752	8938	11474	4432	2004	3305	5053
INFLOWS TO		10	6562	6137	4593	4204	4586	5431	7494	14143	18709	7628	3526	4851	7322
CANYON FERRY		20	5793	5660	4219	3913	4206	5013	7076	11775	16246	6830	2955	4469	6513
RESERVOIR		50	4459	4697	3781	3390	3760	4302	5324	8319	11274	3936	1874	3104	4852
		80	3323	4141	3234	2726	3062	3724	4546	5566	5812	1804	868	2232	3420
		90	3221	3574	2547	2323	2447	3441	3711	4542	4700	1158	507	1738	2826
CANYON FERRY	14	Average	4584	4642	4650	4159	4340	5338	5770	6176	6021	4816	3634	3733	4822
RESERVOIR		10	5504	5625	5848	5868	5983	8162	8801	9447	9205	7595	5346	5359	6895
OUTFLOWS TO		20	5382	5464	5597	5346	5530	6789	7378	7980	7729	6202	4477	4608	6040
MISSOURI RIVER		50	4827	4826	4831	4058	4156	5265	5752	6244	6041	4150	2928	3026	4675
		80	3778	3777	3781	2928	3242	2928	3026	3082	3026	2928	2928	3026	3204
		90	2928	3026	2928	2928	3242	2928	3026	2928	3026	2928	2928	3026	2987
HAUSER LAKE	15	Average	4589	4615	4678	4214	4337	5362	5747	6107	5941	4710	3576	3743	4802
OUTFLOWS TO		10	5509	5627	5850	5867	5984	8102	8815	9394	9133	7431	5301	5377	6866
MISSOURI RIVER		20	5416	5443	5589	5344	5605	6793	7350	7937	7651	6105	4415	4548	6016
		50	4773	4734	4863	4049	4203	5386	5785	6204	5993	3945	2922	3187	4670
		80	3705	3769	3783	2984	3234	3037	3213	3105	3056	2820	2812	2984	3209
		90	3057	2898	3028	2919	3145	2925	3011	2797	2899	2748	2787	2943	2930
MISSOURI	16	Average	4607	4611	4693	4273	4387	5430	5806	6228	6136	4638	3522	3788	4843
RIVER		10	5579	5644	5834	5943	6038	8044	8535	9509	9594	7769	5167	5508	6930
INFLOWS TO		20	5416	5451	5527	5411	5660	6814	7365	8350	8495	5949	4390	4594	6119
HOLTER LAKE		50	4869	4813	4882	4099	4085	5369	5868	6153	5861	3785	2934	3322	4670
		80	3647	3752	3798	3021	3299	3348	3791	3492	3783	2725	2724	2976	3363
		90	3060	2889	3045	2876	3017	2895	2952	2834	2855	2613	2640	2911	2882

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HOLTER LAKE	17	Average	4577	4612	4781	4363	4473	5414	5748	6084	6049	4675	3560	3793	4844
OUTFLOWS		10	5630	5731	5799	5989	6182	7745	8817	9523	9562	7875	5234	5444	6961
TO MISSOURI		20	5429	5441	5568	5549	5639	6996	7291	8321	8327	5911	4360	4654	6124
RIVER		50	4750	4816	4961	4161	4300	5337	5627	5798	5736	3790	3086	3370	4644
		80	3588	3760	3842	3048	3318	3270	3868	3363	3563	2855	2736	2978	3349
		90	2885	2801	3288	2814	3002	2779	3048	2610	2934	2693	2590	2772	2851
SMITH RIVER	18	Average	173	153	124	97	140	170	414	975	987	396	133	135	325
NEAR		10	330	260	242	151	243	265	699	1755	2231	876	274	253	632
EDEN		20	238	186	168	137	173	228	566	1481	1204	623	191	166	447
		50	141	130	106	93	125	156	339	793	791	292	118	104	266
		80	112	103	63	58	80	102	210	487	430	120	47	59	156
		90	88	87	23	38	63	83	179	344	297	49	14	49	110
MISSOURI	19	Average	5096	5161	5292	4944	5061	6156	6984	8830	8914	5730	3827	4117	5843
RIVER NEAR		10	6514	6620	6549	6499	7066	8692	10192	12795	13518	9723	5822	6173	8347
ULM		20	6091	5954	6052	6192	6271	7838	8799	11495	11526	7569	4837	5069	7308
		50	5095	5203	5349	4884	4840	6392	6806	8636	8320	4744	3295	3570	5594
		80	3880	4120	4343	3657	3624	3700	4705	6010	5231	3066	2742	3169	4021
		90	3305	3382	3537	3419	3301	3408	3466	4586	4461	2866	2600	2942	3439
MUDDY	20	Average	110	62	45	34	38	57	42	139	237	253	286	177	123
CREEK		10	145	73	57	49	58	100	57	210	342	359	384	248	174
AT		20	131	71	52	43	49	68	47	169	286	336	360	223	153
VAUGHN		50	109	63	43	34	35	39	35	127	222	246	300	182	120
		80	86	50	35	25	27	32	30	96	170	165	205	125	87
		90	77	48	30	21	22	29	28	66	150	134	167	102	73
SUN RIVER	21	Average	383	329	289	249	264	332	453	1565	2580	625	496	430	666
NEAR		10	503	451	433	342	388	662	920	2884	5034	1355	703	583	1188
VAUGHN		20	445	385	341	305	331	438	688	2397	3443	1099	654	537	922
		50	362	299	259	240	237	272	308	1478	1936	410	480	419	558
		80	282	244	199	171	187	200	184	532	1006	215	300	301	318
		90	233	203	181	131	148	159	152	316	725	20	206	238	226
MISSOURI	22	Average	5674	5475	5391	5026	5324	6590	7521	10365	11046	6384	4424	4595	6484
RIVER AT		10	7110	7236	6796	7043	7341	9454	10668	15763	17233	10545	6657	6470	9360
BLACK EAGLE		20	6685	6597	6388	6546	6715	8483	9327	13095	13864	8899	5570	5817	8165
DAM		50	5779	5422	5533	4887	5035	6545	7373	9992	10123	5479	3786	4068	6169
		80	4409	4369	4474	3670	3758	3972	5233	6647	6453	3445	3169	3555	4429
		90	3700	3458	3477	3206	3357	3637	3909	5734	4827	3025	2914	3272	3710
MISSOURI	23	Average	6024	5825	5740	5376	5674	6940	7871	10715	11396	6733	4774	4945	6834
RIVER BELOW		10	7460	7586	7146	7393	7691	9804	11018	16113	17583	10895	7006	6820	9710
MORONY		20	7035	6946	6738	6896	7065	8833	9677	13445	14214	9248	5920	6167	8515
DAM		50	6129	5772	5883	5237	5385	6895	7723	10342	10473	5829	4136	4418	6519
		80	4759	4718	4824	4020	4108	4322	5583	6997	6803	3794	3519	3905	4779
		90	4050	3808	3827	3556	3707	3987	4259	6084	5177	3375	3264	3622	4060
MISSOURI	24	Average	5881	5839	5789	5456	5787	7046	8078	11388	12330	6828	4693	4956	7006
RIVER AT		10	7422	7645	7266	7487	7720	10013	11245	17481	20016	11323	6971	7096	10140
FORT BENTON		20	7091	6815	6901	7041	7433	9380	10125	14533	15672	9035	5871	6099	8833
		50	5659	5744	5828	5376	5565	7101	7906	10976	11314	5696	4132	4399	6641
		80	4633	4713	4836	3995	4112	4362	5702	7397	7073	3598	3407	3812	4803
		90	3826	3786	3808	3549	3682	4002	4286	6215	5399	3266	3167	3556	4045

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
TETON RIVER	25	Average	51	230	169	140	205	509	478	850	1278	374	94	73	371
NEAR		10	231	706	411	310	549	1208	1149	2163	2382	1254	252	192	901
LOMA		20	54	206	252	230	322	677	839	1703	1629	606	15	94	552
		50	0	0	100	63	111	336	303	383	785	8	0	0	174
		80	0	0	0	0	0	111	0	0	37	0	0	0	12
		90	0	0	0	0	0	32	0	0	0	0	0	0	3
MARIAS RIVER	26	Average	358	355	282	249	354	743	1128	2616	3139	1001	337	274	903
INFLOWS		10	684	606	581	450	720	1514	2014	3851	5959	1940	654	575	1629
TO TIBER		20	487	465	380	319	423	962	1415	3554	4041	1383	487	453	1197
RESERVOIR		50	278	292	221	221	259	468	1058	2406	2476	836	306	207	752
		80	147	177	143	127	158	310	498	1804	1436	386	79	74	445
		90	119	153	123	105	108	254	440	1307	1212	126	0	0	329
TIBER	27	Average	962	767	766	766	768	553	706	813	910	1213	1213	1214	888
RESERVOIR		10	1523	1218	1218	1218	1218	838	1119	1449	1617	2017	2017	2017	1456
OUTFLOWS		20	1281	1025	1025	1025	1025	656	934	1031	1103	1563	1563	1563	1149
TO MARIAS		50	957	765	765	765	765	455	481	473	471	1126	1126	1126	773
RIVER		80	575	460	460	460	460	455	471	455	471	740	740	740	540
		90	423	338	338	338	338	455	471	455	471	504	504	504	428
MARIAS RIVER	28	Average	943	680	562	530	599	476	833	1082	1232	1108	987	948	832
NEAR		10	1371	1117	982	981	1040	909	1495	1673	2832	1967	1822	1808	1500
LOMA		20	1223	906	840	831	894	703	1295	1538	1836	1778	1534	1313	1224
		50	933	694	625	492	613	399	706	1082	908	1013	934	761	763
		80	590	361	160	184	236	198	360	504	408	533	434	401	364
		90	504	307	99	108	158	123	233	365	194	172	318	255	236
MISSOURI	29	Average	6646	6749	6520	6126	6591	8031	9159	13078	14569	7999	5493	5727	8057
RIVER AT		10	8478	8662	8401	8213	9120	11534	12965	18961	21708	13326	8143	8415	11494
VIRGELLE		20	8038	7928	7744	7960	8120	10285	11710	17274	18710	11450	6909	7078	10267
		50	6578	6733	6677	6044	6503	8138	8943	12510	13055	6768	5120	5017	7674
		80	5331	5549	5341	4268	4451	5017	6519	8851	7939	4014	3646	4182	5426
		90	4246	4715	3901	3717	4066	4536	4890	7280	5961	3644	3418	4021	4533
MOUTH	30	Average	382	393	391	412	478	514	502	537	573	516	412	403	459
OF JUDITH		10	576	599	602	639	705	752	835	809	909	768	687	649	711
RIVER		20	542	568	584	591	637	704	719	740	754	690	636	621	649
		50	315	331	276	365	510	536	451	528	554	490	352	266	415
		80	239	243	241	243	245	299	292	297	280	269	211	232	258
		90	237	241	239	241	241	244	257	248	247	228	192	226	237
MISSOURI	31	Average	7101	7297	6966	6517	7135	9287	10271	14097	16420	9080	5980	6206	8863
RIVER NEAR		10	8837	8832	8715	9151	10069	13545	15222	21798	25242	14885	8816	9020	12844
LANDUSKY		20	8664	8376	8437	8188	9346	11624	13450	17931	20424	12737	7447	7810	11203
		50	6994	7318	7178	6442	7137	9052	9644	13800	15279	7800	5556	5502	8475
		80	5681	6145	5632	4548	4763	5736	7178	9336	8768	4428	3829	4617	5888
		90	4529	5399	4120	4000	4412	5231	5512	7855	6453	3924	3584	4095	4926
MUSSELSHELL	32	Average	74	90	76	81	203	518	349	596	939	314	107	112	288
RIVER AT		10	159	162	162	168	449	1009	937	1542	2537	924	269	279	716
MOSBY		20	107	133	127	119	225	620	540	859	1623	452	194	159	430
		50	59	67	59	64	107	272	181	304	572	125	75	66	163
		80	4	18	17	18	36	110	60	80	121	32	13	14	44
		90	0	0	0	0	12	49	46	17	46	2	0	0	14

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG DRY	33	Average	5	3	2	3	56	317	90	32	80	54	19	17	56
CREEK		10	11	6	4	3	206	1042	79	90	264	122	29	13	156
NEAR MOUTH		20	5	4	2	1	64	625	47	21	124	46	13	5	80
		50	2	2	1	0	3	84	11	8	25	8	3	2	12
		80	0	1	0	0	0	9	4	3	3	1	1	0	2
		90	0	0	0	0	0	4	3	1	2	1	0	0	1
MISSOURI	34	Average	7101	6736	6167	6286	7895	13309	12013	14765	17793	9696	6253	6497	9543
RIVER INFLOWS		10	9763	9391	8194	9185	11769	20152	18163	22069	28693	16724	9826	9804	14478
TO FORT PECK		20	8647	8491	7484	8302	10316	15312	14591	19117	22384	12649	8075	8178	11962
RESERVOIR		50	6983	6358	6139	6079	7414	11542	10244	13662	16641	8384	5836	5643	8744
		80	5223	4872	4315	4402	5157	6401	7195	9061	10344	4935	3685	4224	5818
		90	4312	3742	3802	3562	3954	5490	5712	6420	7073	4062	3132	3877	4595
FORT PECK	35	Average	8086	9246	11724	7977	7893	5930	5496	5812	7139	11098	10009	9366	8315
RESERVOIR		10	10509	12105	15001	14113	13513	9564	8734	9429	12129	13890	12300	11828	11926
OUTFLOWS TO		20	9768	11236	14662	12404	12241	8722	7958	8579	10973	13045	11581	10931	11008
MISSOURI RIVER		50	8017	9180	11913	6987	6871	4881	4418	4702	5699	11080	9809	9278	7736
		80	6302	7166	9220	3347	3276	2928	3026	2928	3026	9142	8060	7536	5496
		90	5449	6164	7881	2928	3242	2928	3026	2928	3026	8127	7145	6803	4971

INSTREAM ALTERNATIVE

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG HOLE	1	Average	518	505	395	349	365	462	1537	3499	4228	1435	450	367	1176
RIVER NEAR		10	797	684	526	456	482	706	2428	5534	6588	2448	774	593	1835
MELROSE		20	673	617	457	420	415	530	2068	4549	5903	2024	668	514	1570
		50	469	474	355	347	341	399	1300	3156	4072	1409	450	324	1092
		80	333	360	287	254	289	337	890	2002	2497	666	204	207	694
		90	269	318	269	215	249	312	666	1870	1272	368	47	135	499
BEAVERHEAD	2	Average	261	285	250	206	207	227	273	398	581	456	424	305	323
RIVER		10	456	473	385	308	298	349	487	719	980	768	775	508	542
ABOVE DILLON		20	380	393	332	250	268	308	393	650	841	716	651	424	467
		50	217	280	245	206	209	215	214	345	537	497	390	243	300
		80	109	130	139	112	115	125	140	134	211	168	120	128	136
		90	87	96	94	84	99	102	96	86	123	15	17	70	81
BEAVERHEAD	3	Average	421	571	511	422	444	495	494	306	447	392	312	401	435
RIVER NEAR		10	728	792	678	560	560	626	820	611	915	726	548	640	684
TWIN		20	590	676	602	498	507	562	641	505	676	642	475	568	579
BRIDGES		50	410	559	496	416	437	494	447	206	348	386	308	386	408
		80	156	423	395	325	363	377	311	100	72	41	61	128	229
		90	106	347	338	263	325	348	263	51	0	0	0	91	178
MOUTH OF	4	Average	238	231	179	144	135	165	198	227	304	120	68	224	186
RUBY RIVER		10	301	295	238	180	168	226	331	405	609	330	195	305	299
		20	289	275	209	166	148	209	283	352	530	223	134	283	258
		50	242	232	167	138	130	149	176	208	236	89	40	221	169
		80	180	186	153	121	115	116	102	89	50	0	0	168	107
		90	152	165	147	118	109	109	92	40	0	0	0	154	90

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
JEFFERSON	5	Average	1283	1468	1242	1062	1101	1229	2325	3863	5201	1901	730	990	1866
RIVER NEAR		10	1869	1875	1518	1306	1328	1634	3333	6269	8071	3436	1336	1468	2787
TWIN BRIDGES		20	1622	1724	1395	1205	1235	1422	3034	5137	7176	2775	1079	1277	2423
		50	1270	1420	1210	1053	1071	1164	2030	3466	5108	1809	739	931	1773
		80	871	1203	1044	904	930	1010	1506	2311	2862	723	201	657	1185
		90	723	1086	977	804	845	921	1326	2020	1631	274	0	461	922
JEFFERSON	6	Average	1789	1895	1459	1319	1347	1649	2567	4332	6396	1914	796	1283	2229
RIVER NEAR		10	2597	2381	1933	1621	1846	2025	3498	6911	10700	3591	1694	1921	3393
THREE FORKS		20	2231	2173	1714	1516	1565	1886	3135	6017	9447	2678	1160	1643	2930
		50	1806	1893	1456	1334	1339	1638	2610	3970	6180	1748	727	1191	2158
		80	1146	1519	1137	1087	1034	1395	1688	2242	2913	523	172	866	1310
		90	966	1369	990	980	831	1317	1447	1811	2125	247	0	597	1057
GALLATIN	7	Average	748	813	746	680	709	820	1072	2082	3052	1394	691	637	1120
RIVER NEAR		10	1117	1096	927	861	854	1001	1426	3170	4733	2099	993	976	1605
LOGAN		20	991	991	864	799	809	926	1291	2686	4262	1877	888	851	1436
		50	812	814	763	689	719	809	996	2092	3066	1306	638	630	1111
		80	489	659	610	567	578	706	798	1233	1672	871	485	453	760
		90	340	458	507	480	496	619	703	1043	1305	652	387	220	601
MADISON RIVER	8	Average	863	880	799	776	758	754	929	1666	1926	993	804	826	998
INFLOWS		10	1060	1094	1012	917	899	945	1223	2278	3118	1467	1079	1115	1351
TO HEBGEN		20	949	956	925	894	846	862	1052	2021	2533	1325	1007	960	1194
RESERVOIR		50	808	786	791	758	772	754	881	1594	1814	938	758	762	952
		80	696	655	646	665	663	629	756	1241	1189	700	626	640	759
		90	634	609	585	611	600	583	716	1133	1002	616	579	590	688
HEBGEN	9	Average	1462	1405	872	782	705	815	991	1053	1193	973	883	1102	1020
RESERVOIR		10	1955	1815	1106	923	837	1046	1373	1594	1684	1366	1273	1511	1374
OUTFLOWS TO		20	1688	1596	990	898	780	923	1138	1265	1389	1233	1226	1437	1214
MADISON RIVER		50	1308	1290	853	762	712	796	963	1037	1100	1023	851	998	974
		80	1204	1098	700	672	611	684	811	715	968	642	536	780	785
		90	1175	1044	638	611	564	565	710	703	913	413	472	735	712
MADISON RIVER	10	Average	2016	2079	1412	1280	1240	1429	1561	2130	2797	1773	1381	1579	1723
BELOW		10	2778	2708	1713	1565	1486	1715	2075	2972	3842	2382	1772	2054	2255
ENNIS LAKE		20	2374	2476	1631	1502	1438	1548	1781	2571	3638	1980	1763	2023	2060
		50	1877	1949	1381	1247	1270	1456	1600	1872	2606	1844	1408	1437	1662
		80	1712	1706	1208	1064	1063	1265	1328	1723	2098	1329	959	1261	1393
		90	1646	1557	1127	999	1020	1131	1107	1388	1659	931	791	1183	1211
MADSION RIVER	11	Average	2045	1897	1604	1313	1269	1432	1662	2204	2847	1679	1238	1495	1724
NEAR		10	2844	2446	2040	1577	1536	1731	2167	3033	4044	2522	1707	1952	2300
THREE FORKS		20	2446	2023	1958	1549	1489	1548	1853	2602	3756	1932	1647	1898	2059
		50	1924	1794	1609	1302	1302	1451	1646	2011	2731	1715	1227	1393	1675
		80	1739	1590	1264	1102	1045	1262	1432	1759	2020	1223	724	1189	1362
		90	1676	1525	1176	1033	969	1078	1160	1636	1690	822	602	1124	1208
MISSOURI	12	Average	4538	4769	3717	3263	3606	3967	5656	8681	11500	4715	2307	3240	4997
RIVER AT		10	5957	5896	4334	4031	4270	4786	7377	13161	17815	8129	3737	4714	7017
TOSTON		20	5532	5491	4160	3708	3959	4614	6839	11224	16579	6285	3062	4167	6302
		50	4240	4501	3680	3246	3566	3910	5242	8320	11466	4406	2247	3112	4828
		80	3382	3943	3245	2748	3240	3368	4290	5378	6626	2151	1278	2269	3493
		90	3120	3747	3041	2570	2935	2957	3835	4770	5533	1819	826	1846	3083

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
MISSOURI RIVER	13	Average	4665	4876	3743	3354	3703	4386	5751	8942	11536	4592	2138	3326	5084
INFLOWS TO		10	6561	6136	4593	4203	4585	5431	7494	14144	18746	7798	3678	4867	7353
CANYON FERRY		20	5791	5659	4218	3913	4206	5013	7076	11776	16346	7002	3089	4478	6547
RESERVOIR		50	4458	4696	3780	3390	3759	4301	5324	8320	11341	4104	2021	3134	4886
		80	3321	4140	3234	2725	3061	3724	4546	5569	5923	2010	1007	2282	3462
		90	3220	3573	2546	2322	2447	3440	3711	4542	4764	1319	620	1777	2857
CANYON FERRY	14	Average	4608	4658	4671	4168	4352	5352	5787	6197	6041	4916	3705	3787	4853
RESERVOIR		10	5508	5628	5848	5877	5995	8167	8807	9454	9211	7766	5427	5440	6927
OUTFLOWS TO		20	5376	5459	5578	5357	5571	6801	7392	7995	7743	6355	4565	4658	6071
MISSOURI RIVER		50	4832	4830	4836	4074	4166	5283	5770	6264	6060	4300	2928	3026	4697
		80	3865	3864	3868	2928	3242	2928	3095	3327	3241	2928	2928	3026	3270
		90	2928	3026	2928	2928	3242	2928	3026	2928	3026	2928	2928	3026	2987
HAUSER LAKE	15	Average	4613	4630	4699	4223	4349	5377	5764	6128	5961	4810	3647	3797	4833
OUTFLOWS TO		10	5512	5597	5849	5871	5996	8108	8825	9400	9141	7601	5382	5458	6895
MISSOURI RIVER		20	5415	5442	5588	5355	5625	6806	7364	7952	7666	6249	4505	4569	6045
		50	4809	4758	4862	4066	4213	5397	5797	6241	6015	4097	2937	3218	4701
		80	3761	3856	3870	2984	3257	3037	3231	3300	3059	2820	2832	2984	3249
		90	3057	2938	3028	2919	3169	2925	3011	2797	2926	2748	2791	2943	2938
MISSOURI	16	Average	4630	4627	4714	4282	4399	5445	5823	6250	6156	4737	3593	3842	4875
RIVER		10	5581	5647	5835	5952	6050	8051	8558	9518	9602	7940	5248	5589	6964
INFLOWS TO		20	5412	5447	5511	5422	5660	6829	7379	8374	8505	6104	4483	4656	6149
HOLTER LAKE		50	4877	4813	4894	4109	4095	5386	5893	6164	5877	3918	3081	3322	4702
		80	3752	3834	3873	3021	3299	3356	3791	3552	3867	2739	2732	2977	3399
		90	3060	2889	3101	2876	3076	2895	2952	2834	2855	2629	2640	2911	2893
HOLTER LAKE	17	Average	4600	4628	4802	4372	4484	5428	5765	6105	6069	4774	3631	3848	4875
OUTFLOWS		10	5635	5729	5799	5996	6191	7818	8840	9529	9570	8046	5315	5525	6999
TO MISSOURI		20	5394	5452	5576	5560	5655	7020	7310	8332	8339	6066	4450	4714	6156
RIVER		50	4781	4815	4960	4195	4301	5354	5645	5813	5744	3903	3133	3427	4673
		80	3685	3808	3885	3048	3318	3270	3873	3602	3581	2873	2768	2980	3391
		90	2885	2828	3332	2814	3002	2779	3048	2610	2934	2752	2623	2772	2865
SMITH RIVER	18	Average	173	152	124	97	140	170	414	975	989	399	135	136	325
NEAR		10	330	260	241	151	243	265	699	1755	2232	879	277	255	632
EDEN		20	238	185	168	137	173	228	566	1481	1205	627	194	167	448
		50	140	130	105	93	124	156	339	793	793	295	120	104	266
		80	111	102	62	58	80	102	210	487	431	123	49	60	156
		90	88	87	23	38	63	83	179	345	299	52	17	49	110
MISSOURI	19	Average	5118	5176	5313	4952	5072	6170	7000	8852	8938	5839	3905	4173	5876
RIVER NEAR		10	6512	6573	6553	6508	7073	8697	10201	12814	13541	9903	5909	6226	8376
ULM		20	6089	5953	6047	6220	6273	7869	8842	11521	11543	7751	4937	5119	7347
		50	5095	5226	5372	4890	4851	6409	6830	8663	8451	4880	3342	3605	5635
		80	3940	4186	4412	3656	3631	3738	4705	6031	5266	3119	2754	3172	4051
		90	3351	3381	3545	3418	3300	3407	3466	4586	4466	2890	2630	2944	3449
MUDDY	20	Average	110	62	45	34	38	57	42	139	237	253	286	177	123
CREEK		10	145	73	57	49	58	100	57	210	342	359	384	248	174
AT		20	131	71	52	43	49	68	47	169	286	336	360	223	153
VAUGHN		50	109	63	43	34	35	39	35	127	222	246	300	182	120
		80	86	50	35	25	27	32	30	96	170	165	205	125	87
		90	77	48	30	21	22	29	28	66	150	134	167	102	73

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
SUN RIVER	21	Average	383	329	289	249	264	332	453	1566	2584	634	501	431	668
NEAR		10	503	451	433	342	388	662	920	2885	5036	1364	708	583	1190
VAUGHN		20	445	385	341	305	331	438	688	2397	3447	1112	660	538	924
		50	362	299	259	240	237	272	308	1480	1940	420	485	421	560
		80	282	244	199	171	187	200	184	534	1013	227	305	301	321
		90	233	203	181	131	148	159	152	318	730	31	213	238	228
MISSOURI	22	Average	5697	5490	5411	5034	5335	6604	7537	10388	11074	6502	4508	4652	6519
RIVER AT		10	7114	7189	6795	7051	7245	9490	10705	15779	17315	10719	6763	6561	9394
BLACK EAGLE		20	6684	6599	6387	6553	6733	8506	9370	13121	13889	9072	5844	5868	8219
DAM		50	5778	5426	5559	4892	5055	6562	7409	10020	10203	5670	3923	4179	6223
		80	4452	4426	4561	3669	3758	4011	5233	6654	6482	3464	3184	3562	4455
		90	3736	3457	3490	3205	3357	3637	3908	5735	4839	3063	2979	3273	3723
MISSOURI	23	Average	6047	5840	5761	5384	5685	6954	7887	10738	11424	6852	4858	5002	6869
RIVER BELOW		10	7464	7539	7145	7401	7595	9840	11055	16129	17665	11069	7113	6911	9744
MORONY		20	7034	6949	6737	6903	7083	8856	9720	13471	14239	9422	6194	6218	8569
DAM		50	6128	5776	5909	5242	5405	6912	7759	10370	10553	6020	4273	4529	6573
		80	4802	4776	4911	4019	4107	4361	5583	7004	6832	3814	3534	3912	4805
		90	4086	3807	3840	3555	3707	3986	4258	6085	5189	3413	3329	3623	4073
MISSOURI	24	Average	5904	5854	5809	5464	5798	7060	8095	11426	12424	7072	4857	5046	7067
RIVER AT		10	7420	7548	7264	7488	7720	10022	11257	17510	20156	11658	7107	7199	10196
FORT BENTON		20	7090	6814	6900	7051	7449	9394	10149	14555	15768	9305	6015	6125	8885
		50	5677	5760	5850	5376	5580	7120	7923	11026	11525	5996	4281	4556	6723
		80	4623	4772	4870	3994	4113	4399	5702	7436	7191	3739	3503	3883	4852
		90	3825	3784	3823	3549	3681	4002	4286	6239	5555	3479	3327	3595	4095
TETON RIVER	25	Average	51	230	169	140	205	509	478	850	1278	375	94	73	371
NEAR		10	230	706	411	310	548	1208	1149	2163	2382	1255	252	192	901
LOMA		20	53	206	252	230	322	677	839	1703	1629	607	15	94	552
		50	0	0	100	63	111	336	303	383	785	9	0	0	174
		80	0	0	0	0	0	111	0	0	37	0	0	0	12
		90	0	0	0	0	0	32	0	0	0	0	0	0	3
MARIAS RIVER	26	Average	358	355	282	249	354	743	1128	2618	3146	1014	345	277	906
INFLOWS		10	685	606	581	450	720	1514	2014	3851	5962	1947	661	580	1631
TO TIBER		20	487	465	380	319	423	962	1415	3554	4047	1399	499	459	1201
RESERVOIR		50	279	292	221	221	259	468	1058	2407	2484	851	313	212	756
		80	148	177	143	127	158	310	498	1804	1447	395	91	80	448
		90	119	153	123	105	108	254	440	1310	1224	143	0	0	332
TIBER	27	Average	961	767	766	766	768	554	707	814	903	1219	1219	1220	889
RESERVOIR		10	1524	1219	1219	1219	1219	839	1120	1452	1618	2022	2022	2022	1458
OUTFLOWS		20	1280	1024	1024	1024	1024	657	936	1033	1105	1568	1568	1568	1151
TO MARIAS		50	956	765	765	765	765	455	482	475	471	1130	1130	1130	774
RIVER		80	576	461	461	461	461	455	471	455	471	747	747	747	543
		90	423	338	338	338	338	455	471	455	471	511	511	511	430
MARIAS RIVER	28	Average	943	680	562	530	599	476	834	1090	1245	1158	1023	966	842
NEAR		10	1369	1116	982	981	1039	910	1495	1687	2839	2004	1849	1818	1507
LOMA		20	1223	906	839	830	894	704	1297	1546	1869	1830	1558	1334	1236
		50	932	694	625	491	613	399	707	1087	931	1068	1002	777	777
		80	590	362	160	184	237	198	363	507	454	585	463	422	377
		90	504	308	100	109	159	123	234	381	227	218	357	280	250

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
MISSOURI RIVER AT VIRGELLE	29	Average	6669	6764	6541	6134	6602	8046	9177	13131	14701	8341	5725	5849	8140
		10	8476	8646	8404	8224	9054	11545	13002	18984	21876	13766	8339	8546	11572
		20	8036	7930	7743	7965	8135	10352	11728	17312	18869	11916	7191	7228	10367
		50	6602	6741	6723	6051	6531	8157	8960	12562	13205	7172	5355	5130	7766
		80	5355	5591	5371	4267	4451	5022	6521	8911	8085	4313	3824	4311	5502
		90	4312	4714	3966	3717	4228	4536	4890	7329	6134	3908	3627	4073	4620
MOUTH OF JUDITH RIVER	30	Average	381	393	391	412	478	514	502	538	579	536	429	406	463
		10	575	599	602	639	705	752	835	811	912	787	703	654	715
		20	541	568	584	591	637	704	719	740	760	707	653	622	652
		50	314	331	276	365	510	536	451	528	556	508	364	267	417
		80	238	242	241	243	245	299	292	300	289	293	229	235	262
		90	236	241	239	241	241	244	257	251	256	250	212	233	242
MISSOURI RIVER NEAR LANDUSKY	31	Average	7123	7312	6986	6525	7146	9301	10289	14151	16558	9443	6229	6331	8950
		10	8826	8829	8712	9162	10037	13567	15233	21890	25409	15349	9005	9153	12931
		20	8663	8374	8558	8204	9350	11659	13485	17971	20539	13187	7861	7880	11311
		50	7032	7305	7170	6456	7162	9064	9662	13807	15477	8171	5806	5604	8560
		80	5736	6199	5669	4547	4763	5736	7205	9420	8922	4829	4031	4746	5983
		90	4527	5414	4119	3998	4412	5252	5511	7905	6705	4211	3828	4279	5014
MUSSELSHELL RIVER AT MOSBY	32	Average	74	90	76	81	203	518	349	596	939	314	107	112	288
		10	159	162	162	168	449	1009	937	1542	2537	924	269	279	716
		20	107	133	127	119	225	620	540	859	1623	452	194	159	430
		50	59	67	59	64	107	272	181	304	572	125	75	66	163
		80	4	18	17	18	36	110	60	80	121	32	13	14	44
		90	0	0	0	0	12	49	46	17	46	2	0	0	14
BIG DRY CREEK NEAR MOUTH	33	Average	5	3	2	3	56	317	90	32	80	54	19	17	56
		10	11	6	4	3	206	1042	79	90	264	122	29	13	156
		20	5	4	2	1	64	625	47	21	124	46	13	5	80
		50	2	2	1	0	3	84	11	8	25	8	3	2	12
		80	0	1	0	0	0	9	4	3	3	1	1	0	2
		90	0	0	0	0	0	4	3	1	2	1	0	0	1
MISSOURI RIVER INFLOWS TO FORT PECK RESERVOIR	34	Average	7123	6751	6188	6294	7907	13324	12031	14818	17931	10060	6503	6621	9629
		10	9760	9392	8192	9124	11671	20160	18191	22100	28861	17187	10113	10134	14574
		20	8560	8461	7483	8310	10334	15333	14610	19166	22500	13049	8353	8328	12041
		50	6990	6383	6011	6110	7429	11498	10262	13722	16895	8751	6104	5699	8821
		80	5291	4870	4379	4402	5156	6408	7200	9074	10489	5267	3905	4328	5898
		90	4311	3781	3949	3561	4011	5490	5722	6452	7300	4475	3359	4103	4710
FORT PECK RESERVOIR OUTFLOWS TO MISSOURI RIVER	35	Average	8164	9338	11832	8057	7975	5990	5548	5872	7219	11199	10120	9466	8398
		10	10584	12193	15001	14180	13609	9640	8804	9505	12233	13974	12413	11910	12004
		20	9855	11338	14799	12513	12350	8800	8030	8657	11079	13142	11668	11018	11104
		50	8093	9269	12032	7082	6965	4949	4480	4769	5791	11173	9893	9364	7822
		80	6376	7254	9337	3505	3418	2928	3026	2928	3026	9222	8133	7606	5563
		90	5572	6309	8074	2928	3242	2928	3026	2928	3026	8221	7230	6894	5032

Table C-3. Percentage reductions in monthly streamflows

CONSUMPTIVE USE ALTERNATIVE

MODEL NODE		%FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG HOLE	1	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MELROSE		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEAVERHEAD	2	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ABOVE DILLON		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEAVERHEAD	3	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWIN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRIDGES		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOUTH OF	4	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUBY RIVER		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JEFFERSON	5	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWIN BRIDGES		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JEFFERSON	6	Average	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.0	0.0	1.5	11.7	23.1	3.1	2.0
RIVER NEAR		10	-0.1	-0.0	-0.1	-0.1	-0.1	-0.0	0.0	-0.0	1.2	6.8	14.3	0.7	1.5
THREE FORKS		20	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0	0.0	1.7	9.7	18.4	3.5	1.9
		50	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0	0.2	1.2	8.8	28.6	3.7	1.9
		80	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	2.9	51.2	100.0	4.3	3.5
		90	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	6.7	100.0	0.0	4.2	3.2
GALLATIN	7	Average	-0.3	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.4	2.9	0.0	0.3
RIVER NEAR		10	-0.2	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	1.0	2.6	-0.1	0.2
LOGAN		20	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.4	0.4	0.2
		50	-0.2	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	1.4	3.4	-0.3	0.3
		80	-0.2	-0.3	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.2	2.6	-4.3	0.7	0.5
		90	-0.3	-0.2	-0.2	0.0	-0.2	0.0	0.0	0.0	0.5	2.5	5.4	-0.9	0.5
MADISON RIVER	8	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
INFLOWS		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TO HEBGEN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESERVOIR		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HEBGEN	9	Average	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESERVOIR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OUTFLOWS TO		20	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
MADISON RIVER		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MADISON RIVER	10	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
BELOW		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENNIS LAKE		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
MADSION RIVER	11	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.4	6.0	6.8	0.9	1.2
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	3.7	5.0	0.9	0.8
THREE FORKS		20	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.6	4.4	3.8	0.9	0.8
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.6	5.5	7.6	0.9	1.2
		80	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.4	1.5	7.8	10.9	2.0	1.4
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	11.3	14.8	1.9	1.8
MISSOURI	12	Average	-0.1	-0.0	-0.1	-0.0	-0.1	-0.0	-0.0	0.1	1.2	7.3	12.5	1.7	1.4
RIVER AT		10	-0.1	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.4	4.4	9.9	0.7	1.0
TOSTON		20	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.1	1.4	5.2	10.4	0.7	1.2
		50	-0.1	-0.1	-0.1	-0.1	-0.0	-0.1	-0.0	-0.0	1.3	8.0	13.1	1.2	1.4
		80	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0	-0.0	0.3	1.4	15.5	18.4	2.6	1.7
		90	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0	-0.0	0.0	4.0	19.5	27.5	3.6	2.3
MISSOURI RIVER	13	Average	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0	-0.0	0.2	2.0	12.0	20.5	3.1	2.2
INFLOWS TO		10	-0.1	-0.1	-0.1	-0.0	-0.0	-0.0	-0.0	0.0	0.8	7.7	13.7	1.1	1.5
CANYON FERRY		20	-0.1	-0.1	-0.1	-0.1	-0.0	-0.0	0.0	0.0	1.3	8.7	14.9	1.1	1.7
RESERVOIR		50	0.0	-0.1	-0.1	-0.1	-0.1	-0.0	-0.0	0.0	2.1	14.6	20.0	5.2	2.4
		80	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0	0.1	6.5	32.9	44.0	9.0	4.2
		90	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.4	4.5	41.8	69.9	11.6	4.3
CANYON FERRY	14	Average	2.2	1.4	1.8	1.1	2.0	0.9	0.9	1.0	1.0	7.0	6.4	4.1	2.3
RESERVOIR		10	0.2	-0.0	0.1	1.1	0.8	0.3	0.3	0.3	0.3	7.7	5.2	4.4	1.6
OUTFLOWS TO		20	0.2	-0.0	-0.1	0.8	2.9	0.8	0.8	0.8	0.8	8.3	7.0	4.0	2.0
MISSOURI RIVER		50	1.3	1.4	1.3	1.5	4.5	1.2	1.2	1.3	1.2	11.8	0.0	0.0	2.2
		80	24.9	7.6	7.7	0.0	0.0	0.0	3.7	13.2	7.9	0.0	0.0	0.0	6.1
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HAUSER LAKE	15	Average	2.2	1.4	1.8	1.1	2.0	0.9	0.9	1.1	1.0	7.2	6.5	4.1	2.3
OUTFLOWS TO		10	0.2	-1.1	0.1	0.3	0.8	0.3	0.5	0.3	0.4	7.9	5.2	5.2	1.6
MISSOURI RIVER		20	0.1	-0.0	-0.1	0.8	1.7	0.8	-0.9	0.8	0.8	8.2	7.6	2.8	1.7
		50	2.3	0.9	0.0	1.5	2.6	1.5	0.8	2.0	1.3	13.4	1.0	2.9	2.4
		80	17.8	7.7	7.6	0.0	0.7	0.5	1.6	8.2	0.5	0.8	1.0	1.0	4.4
		90	4.4	3.7	0.4	1.2	6.4	0.0	0.0	0.0	0.9	0.1	2.0	1.4	1.8
MISSOURI	16	Average	2.2	1.4	1.8	1.0	2.0	0.9	0.9	1.0	1.0	7.3	6.6	4.1	2.3
RIVER		10	0.4	0.2	0.4	0.6	0.7	0.4	1.1	0.5	0.3	7.7	5.4	5.3	1.8
INFLOWS TO		20	-0.1	-0.0	0.1	0.8	1.5	0.8	0.8	1.4	0.4	8.9	9.0	3.1	2.0
HOLTER LAKE		50	1.0	0.9	0.7	0.9	3.4	1.2	1.8	0.7	1.2	12.3	7.2	4.4	2.5
		80	16.0	7.8	7.2	0.0	0.0	2.7	0.0	3.9	2.8	2.5	1.7	0.8	4.1
		90	2.8	0.9	2.0	1.3	8.6	0.0	0.0	0.0	2.0	0.8	3.4	0.4	1.9

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HOLTER LAKE	17	Average	2.1	1.4	1.7	1.0	1.9	0.9	0.9	1.1	1.0	7.3	6.6	4.1	2.3
OUTFLOWS		10	0.9	-0.1	1.4	0.4	0.6	2.1	1.0	0.5	0.7	7.6	5.3	5.1	2.1
TO MISSOURI		20	-0.6	0.2	0.6	0.7	1.4	1.2	1.2	0.4	0.6	8.9	8.3	4.8	2.1
RIVER		50	2.3	0.2	-0.1	2.7	0.9	0.9	1.5	0.9	0.6	11.2	5.4	4.1	2.2
		80	13.0	4.5	6.2	0.3	0.2	0.0	1.1	10.4	2.1	1.8	1.8	2.1	3.8
		90	0.0	4.1	5.8	0.0	0.0	0.0	0.0	0.0	0.0	4.2	4.0	2.8	1.8
SMITH RIVER	18	Average	-0.6	-0.7	0.0	-1.0	0.0	0.0	0.0	0.1	0.9	5.7	12.8	6.5	1.5
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.0	6.7	3.5	0.6
EDEN		20	0.4	-0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.8	3.8	10.4	4.7	1.1
		50	0.0	-0.8	0.0	0.0	-0.8	0.0	0.0	0.1	1.3	6.3	12.1	4.7	1.5
		80	-0.9	0.0	-1.6	0.0	0.0	0.0	0.0	0.0	2.1	14.7	39.3	11.3	3.2
		90	-1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	4.9	40.0	91.7	14.0	5.4
MISSOURI	19	Average	1.9	1.2	1.5	0.9	1.7	0.8	0.8	0.8	0.9	6.8	7.1	4.1	2.1
RIVER NEAR		10	-0.0	-0.6	0.1	1.0	0.1	0.2	0.4	0.4	0.6	6.6	5.1	4.3	1.5
ULM		20	-0.1	-0.0	0.1	1.1	1.2	1.4	-0.1	0.9	0.6	8.2	8.3	5.3	2.0
		50	1.2	1.5	0.9	0.6	1.1	1.1	1.6	1.3	2.1	9.4	4.8	2.0	2.1
		80	6.8	3.8	5.6	0.9	1.4	3.5	-0.1	1.0	2.6	3.1	4.2	2.5	2.8
		90	3.0	-0.1	1.5	-0.1	1.0	-0.0	-0.0	0.1	0.6	5.6	4.9	2.3	1.4
MUDDY	20	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.4	2.4	1.7	1.6
CREEK		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.7	1.5	2.4	1.1
AT		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.4	2.6	2.4	1.8	1.3
VAUGHN		50	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.8	1.8	3.5	2.0	0.5	1.6
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	5.7	3.3	2.3	2.2
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.6	5.0	4.6	1.9	2.7
SUN RIVER	21	Average	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.5	12.1	9.2	2.5	2.2
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	3.8	5.2	1.4	0.8
VAUGHN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	9.8	7.0	1.7	1.7
		50	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.9	1.5	19.8	9.3	3.3	2.8
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.4	5.5	42.9	15.1	5.0	6.2
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	6.7	100.0	29.5	0.0	6.1
MISSOURI	22	Average	1.7	1.1	1.5	0.9	1.6	0.7	0.7	0.7	1.1	7.3	7.2	4.0	2.1
RIVER AT		10	0.2	-0.7	-0.1	0.9	-0.5	1.3	1.1	0.4	1.6	6.8	6.3	5.3	1.8
BLACK EAGLE		20	-0.0	0.4	0.1	0.5	0.9	0.9	-0.1	0.8	0.9	7.6	10.1	2.1	1.9
DAM		50	0.9	-0.4	1.7	0.4	1.4	0.9	1.5	1.2	2.0	13.5	6.4	5.5	2.6
		80	1.9	3.1	6.3	2.7	1.3	2.3	-0.1	0.5	2.3	7.4	3.0	2.9	2.6
		90	5.6	-0.1	1.1	-0.1	2.0	-0.0	-0.0	0.2	1.8	5.6	8.2	2.6	2.1
MISSOURI	23	Average	1.6	1.1	1.4	0.8	1.5	0.7	0.7	0.7	1.1	6.9	6.7	3.7	2.0
RIVER BELOW		10	0.2	-0.7	-0.1	0.9	-0.5	1.2	1.1	0.4	1.6	6.6	6.0	5.0	1.8
MORONY		20	-0.0	0.4	0.1	0.4	0.9	0.9	-0.1	0.8	0.9	7.3	9.5	2.0	1.8
DAM		50	0.9	-0.3	1.6	0.4	1.3	0.9	1.4	1.2	1.9	12.7	5.9	5.0	2.5
		80	1.8	2.8	5.9	2.5	1.1	2.1	-0.1	0.5	2.2	6.8	2.7	2.7	2.4
		90	5.2	-0.1	1.0	-0.1	1.8	-0.0	-0.0	0.2	1.7	5.0	7.3	2.3	1.9
MISSOURI	24	Average	1.7	1.1	1.4	0.8	1.5	0.7	0.7	0.8	1.5	8.4	8.3	4.3	2.3
RIVER AT		10	-0.1	-1.3	-0.1	0.0	-0.2	0.4	0.4	0.4	1.7	8.2	6.3	5.1	1.8
FORT BENTON		20	-0.0	-0.0	-0.1	0.6	1.0	0.5	0.2	0.5	1.3	7.9	9.4	3.6	1.9
		50	0.8	-0.1	1.3	0.1	3.3	1.0	1.0	1.4	2.2	12.5	7.1	5.9	2.7
		80	6.4	2.9	4.5	2.3	0.4	1.3	-0.1	0.9	3.2	8.0	5.0	3.8	3.0
		90	3.0	-0.1	1.8	-0.1	0.1	-0.0	-0.0	0.5	4.9	9.4	11.6	3.0	2.7

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
TETON RIVER	25	Average	0.0	-0.4	-0.6	0.0	0.0	0.0	0.0	0.6	2.3	11.0	12.1	8.0	2.1
NEAR		10	-0.9	-0.3	0.0	0.0	-0.2	0.0	-0.1	0.0	0.4	5.9	24.9	-1.1	1.3
LOMA		20	0.0	-1.0	-0.4	-0.4	0.0	-0.1	0.0	0.8	1.5	14.4	92.7	30.5	2.9
		50	0.0	0.0	-1.0	-1.6	0.0	0.0	0.0	0.3	3.5	100.0	0.0	0.0	3.4
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	35.7
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARIAS RIVER	26	Average	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	2.5	4.0	2.2	0.6
INFLOWS		10	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	2.1	1.5	0.2
TO TIBER		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.1	4.4	2.4	0.5
RESERVOIR		50	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	3.0	3.8	5.1	0.8
		80	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	4.3	22.1	12.2	1.3
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.9	20.8	0.0	0.0	1.5
TIBER	27	Average	-0.1	0.0	0.0	0.0	0.0	0.2	0.3	0.4	-0.7	0.8	0.8	0.8	0.2
RESERVOIR		10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1	0.5	0.5	0.5	0.3
OUTFLOWS		20	-0.2	-0.2	-0.2	-0.2	-0.2	0.5	0.4	0.3	0.4	0.6	0.6	0.6	0.3
TO MARIAS		50	-0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.7	0.7	0.7	0.4
RIVER		80	0.5	0.4	0.4	0.4	0.4	0.0	0.0	0.0	0.0	1.7	1.7	1.7	0.9
		90	0.2	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	2.5	2.5	2.5	0.9
MARIAS RIVER	28	Average	0.1	0.0	0.0	0.0	-0.2	0.4	0.4	3.3	9.0	21.6	17.1	8.1	6.5
NEAR		10	-0.2	-0.1	0.0	0.0	-0.1	0.3	0.0	2.1	3.7	9.6	7.7	2.1	2.8
LOMA		20	-0.1	0.0	-0.1	-0.1	-0.1	0.4	0.3	3.0	9.2	14.7	11.1	8.1	5.2
		50	-0.2	0.0	0.0	-0.2	0.0	0.0	0.7	2.2	13.8	27.2	22.4	10.7	8.1
		80	0.7	0.3	0.6	0.0	0.4	0.0	1.7	1.0	45.7	48.0	37.7	17.6	16.8
		90	0.2	0.3	1.0	0.9	0.6	0.0	0.9	11.5	79.9	100.0	53.8	35.2	25.3
MISSOURI	29	Average	1.5	0.9	1.2	0.7	1.3	0.6	0.6	1.3	3.0	13.5	13.1	6.3	3.4
RIVER AT		10	-0.1	-0.2	0.1	0.8	-0.3	0.4	0.9	0.5	2.3	10.8	8.4	4.7	2.5
VIRGELLE		20	-0.1	0.3	-0.1	0.3	0.6	1.9	0.6	0.7	2.9	13.0	9.4	7.2	3.0
		50	2.0	0.4	1.1	0.4	2.3	0.9	0.7	1.3	3.6	19.1	14.3	5.6	3.9
		80	12.1	3.4	3.0	-0.1	1.6	0.2	-0.0	2.4	6.2	23.9	14.6	8.4	5.7
		90	1.5	-0.1	2.7	-0.1	6.9	-0.0	0.0	2.3	10.2	21.3	24.0	8.3	6.0
MOUTH	30	Average	-1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7	4.1	14.4	15.0	3.4	3.2
OF JUDITH		10	-0.5	-0.2	0.0	0.0	0.0	0.0	0.0	1.0	1.3	9.1	9.0	1.5	2.0
RIVER		20	-0.7	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.9	10.7	10.4	0.8	2.1
		50	-1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	14.4	12.6	1.1	2.6
		80	-1.3	-0.4	0.0	0.0	0.0	0.0	0.0	3.0	9.2	26.6	29.4	8.4	6.4
		90	-1.3	-0.4	0.0	0.0	0.0	0.0	0.0	3.2	12.1	31.6	33.2	9.7	7.3
MISSOURI	31	Average	1.4	0.8	1.2	0.7	1.2	0.5	0.6	1.2	2.8	12.8	13.1	6.0	3.3
RIVER NEAR		10	0.1	-0.1	-0.1	0.4	0.3	0.6	0.6	1.4	2.0	10.7	8.5	4.2	2.5
LANDUSKY		20	0.0	-0.1	1.9	0.8	0.3	1.0	0.9	0.7	1.8	10.3	11.7	4.3	2.7
		50	2.0	-0.1	0.2	0.7	1.1	0.5	0.8	0.9	4.5	16.5	12.6	4.8	3.5
		80	9.6	3.0	2.9	-0.1	1.0	-0.0	0.9	2.8	6.0	23.9	15.7	9.0	5.6
		90	-0.1	3.5	-0.0	2.1	2.1	2.1	0.0	2.2	11.9	23.9	20.7	11.5	6.3
MUSSELSHELL	32	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER AT		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOSBY		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Consumptive use alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG DRY	33	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CREEK		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEAR MOUTH		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSOURI	34	Average	1.4	0.9	1.3	0.7	1.1	0.4	0.5	1.2	2.6	12.0	12.5	5.8	3.1
RIVER INFLOWS		10	-0.0	0.1	-0.1	-0.1	-0.4	0.1	0.5	0.5	1.7	7.4	9.0	5.0	1.9
TO FORT PECK		20	-0.9	-0.4	-0.0	0.4	0.5	0.6	0.3	1.0	1.7	9.1	11.5	6.5	2.4
RESERVOIR		50	0.4	1.3	-0.8	1.7	0.5	0.2	0.7	1.6	3.8	14.8	15.2	7.3	3.6
		80	3.3	-0.1	5.3	1.2	1.2	0.0	0.3	0.7	5.0	19.2	17.8	6.1	4.4
		90	0.1	3.7	3.7	-0.1	1.4	0.2	0.2	1.3	10.6	23.5	25.9	12.3	6.5
FORT PECK	35	Average	3.3	3.4	3.1	3.1	3.1	3.1	2.9	3.1	3.5	3.1	3.4	3.8	3.3
RESERVOIR		10	2.2	2.3	0.0	1.1	0.9	2.0	2.0	2.0	2.2	2.1	1.2	2.3	1.6
OUTFLOWS TO		20	3.1	3.1	3.2	2.9	2.9	2.9	3.0	3.0	3.2	2.5	2.5	2.8	2.9
MISSOURI RIVER		50	3.5	3.6	3.7	5.3	5.4	5.4	5.5	5.7	6.4	2.8	2.9	3.3	4.1
		80	4.4	4.5	4.7	11.8	7.2	0.0	0.0	0.0	0.0	2.6	2.6	3.2	3.6
		90	6.0	6.3	6.5	0.0	0.0	0.0	0.0	0.0	0.0	4.2	4.3	4.6	3.7

COMBINATION ALTERNATIVE

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG HOLE	1	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MELROSE		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEAVERHEAD	2	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ABOVE DILLON		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEAVERHEAD	3	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWIN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRIDGES		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOUTH OF	4	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUBY RIVER		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
JEFFERSON	5	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWIN BRIDGES		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JEFFERSON	6	Average	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.0	0.0	0.3	2.8	5.5	0.7	0.5
RIVER NEAR		10	-0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.3	1.6	3.3	0.2	0.4
THREE FORKS		20	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.2	4.1	0.8	0.4
		50	0.0	-0.1	0.0	0.0	0.0	0.0	-0.0	0.0	0.3	1.7	7.2	0.3	0.4
		80	-0.1	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.7	11.9	30.8	0.8	0.8
		90	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.5	24.3	0.0	1.8	0.9
GALLATIN	7	Average	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9	1.9	0.0	0.2
RIVER NEAR		10	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.7	1.7	-0.1	0.2
LOGAN		20	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.5	0.2	0.1
		50	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8	2.2	-0.2	0.2
		80	-0.2	-0.2	-0.2	0.0	-0.2	0.0	0.0	0.0	0.1	1.7	2.9	0.7	0.3
		90	-0.3	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.4	1.5	3.6	-0.5	0.3
MADISON RIVER	8	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
INFLOWS		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TO HEBGEN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESERVOIR		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEBGEN	9	Average	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESERVOIR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OUTFLOWS TO		20	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
MADISON RIVER		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MADISON RIVER	10	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
BELOW		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENNIS LAKE		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
MADSION RIVER	11	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.4	6.0	6.8	0.9	1.2
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	3.7	5.0	0.9	0.8
THREE FORKS		20	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.6	4.4	3.8	0.9	0.8
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.6	5.5	7.6	0.9	1.2
		80	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.4	1.5	7.8	10.9	2.0	1.4
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	11.3	14.8	1.9	1.8
MISSOURI	12	Average	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0	0.1	0.6	3.6	6.1	0.7	0.7
RIVER AT		10	-0.0	-0.0	-0.0	0.0	-0.0	0.0	0.0	0.0	0.2	2.1	4.6	0.3	0.4
TOSTON		20	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	0.1	0.6	2.4	5.2	0.4	0.6
		50	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	0.6	3.7	5.6	0.5	0.6
		80	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.3	0.8	7.7	9.0	0.3	0.8
		90	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	0.0	1.9	11.6	11.6	1.3	1.2

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
MISSOURI RIVER	13	Average	-0.0	-0.0	-0.0	-0.1	-0.0	0.0	-0.0	0.1	0.8	4.9	8.6	1.1	0.9
INFLOWS TO		10	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	0.3	3.1	5.6	0.6	0.6
CANYON FERRY		20	-0.1	-0.0	-0.0	-0.0	0.0	-0.0	0.0	0.0	0.8	3.5	5.8	0.3	0.7
RESERVOIR		50	0.0	-0.0	-0.1	-0.0	-0.0	-0.0	-0.0	0.0	0.8	5.7	10.2	1.7	1.0
		80	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.1	2.7	13.9	19.0	3.5	1.7
		90	-0.1	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	0.1	1.8	15.9	26.7	3.9	1.6
CANYON FERRY	14	Average	0.8	0.6	0.8	0.3	0.4	0.4	0.4	0.5	0.5	2.9	2.3	2.1	0.9
RESERVOIR		10	0.1	0.1	-0.0	0.2	0.3	0.1	0.1	0.1	0.1	3.1	2.1	2.1	0.7
OUTFLOWS TO		20	-0.2	-0.1	-0.4	0.3	1.1	0.3	0.3	0.3	0.3	3.3	2.7	1.9	0.8
MISSOURI RIVER		50	0.1	0.1	0.1	0.5	0.4	0.5	0.4	0.5	0.4	4.8	0.0	0.0	0.7
		80	3.2	3.2	3.2	0.0	0.0	0.0	3.7	8.6	7.9	0.0	0.0	0.0	2.6
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HAUSER LAKE	15	Average	0.8	0.6	0.8	0.3	0.4	0.4	0.4	0.5	0.5	2.9	2.3	2.1	0.9
OUTFLOWS TO		10	0.1	-0.7	-0.1	0.1	0.3	0.1	0.2	0.1	0.1	3.2	2.1	2.1	0.6
MISSOURI RIVER		20	-0.1	-0.0	-0.0	0.3	0.5	0.3	0.3	0.3	0.3	3.2	3.0	1.3	0.7
		50	1.0	0.7	0.0	0.5	0.4	0.3	0.3	0.8	0.6	5.1	0.5	1.4	0.9
		80	2.1	3.2	3.2	0.0	0.7	0.0	1.6	7.2	0.5	0.0	0.7	0.4	1.7
		90	0.4	3.7	0.0	0.0	0.8	0.0	0.0	0.0	0.9	0.1	0.1	0.3	0.5
MISSOURI	16	Average	0.8	0.6	0.8	0.3	0.4	0.4	0.4	0.5	0.5	3.0	2.4	2.0	0.9
RIVER		10	0.0	0.1	0.4	0.2	0.3	0.1	0.4	0.1	0.1	3.0	2.2	2.0	0.7
INFLOWS TO		20	-0.1	0.0	-0.3	0.3	0.1	0.3	0.3	0.4	0.2	3.6	3.0	2.2	0.7
HOLTER LAKE		50	0.2	-0.0	0.4	0.3	0.4	0.4	0.6	0.3	0.4	4.6	5.4	0.0	0.9
		80	4.0	3.1	3.1	0.0	0.0	0.2	0.0	2.5	2.4	1.3	0.3	0.2	1.6
		90	0.0	0.0	1.8	0.0	1.9	0.0	0.0	0.0	0.0	0.8	0.0	0.2	0.4
HOLTER LAKE	17	Average	0.7	0.6	0.8	0.3	0.4	0.4	0.4	0.5	0.5	3.0	2.3	2.1	0.9
OUTFLOWS		10	0.1	-0.1	1.4	0.2	0.2	1.3	0.4	0.1	0.1	3.0	2.1	2.1	0.9
TO MISSOURI		20	-0.7	0.2	0.2	0.3	0.4	0.5	0.3	0.2	0.2	3.6	3.0	2.1	0.8
RIVER		50	0.8	-0.0	-0.0	1.1	0.0	0.5	0.4	0.3	0.2	4.4	1.6	1.7	0.8
		80	3.7	1.6	1.5	0.0	0.0	0.0	0.2	7.6	1.1	1.6	1.2	0.6	1.7
		90	0.0	4.1	1.6	0.0	0.0	0.0	0.0	0.0	0.0	2.4	1.3	1.6	0.9
SMITH RIVER	18	Average	-0.6	-0.7	0.0	-1.0	0.0	0.0	0.0	0.0	0.5	2.7	5.7	2.9	0.6
NEAR		10	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.9	3.2	1.9	0.2
EDEN		20	0.0	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.9	5.4	1.8	0.4
		50	-0.7	-0.8	-1.0	0.0	-0.8	0.0	0.0	0.0	0.6	3.3	4.8	1.9	0.4
		80	-1.8	-1.0	-1.6	0.0	0.0	0.0	0.0	0.0	0.9	7.0	16.1	4.8	1.3
		90	-1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.3	18.3	41.7	2.0	1.8
MISSOURI	19	Average	0.6	0.5	0.7	0.2	0.3	0.3	0.3	0.4	0.5	3.1	2.9	2.1	0.9
RIVER NEAR		10	-0.0	-0.7	0.1	0.2	0.1	0.1	0.1	0.2	0.3	2.8	2.0	1.0	0.5
ULM		20	-0.1	-0.0	-0.1	0.7	0.2	0.5	0.7	0.3	0.3	3.6	3.3	2.1	0.9
		50	0.0	0.5	0.5	0.1	0.3	0.4	0.5	0.5	1.8	4.4	2.3	1.3	1.0
		80	2.4	1.6	2.2	-0.1	0.2	1.4	-0.0	0.5	1.3	2.5	1.4	0.5	1.1
		90	1.3	-0.1	1.5	-0.1	-0.1	-0.0	-0.0	0.0	0.5	1.9	2.3	0.9	0.6
MUDDY	20	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.4	2.4	1.7	1.6
CREEK		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.7	1.5	2.4	1.1
AT		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.4	2.6	2.4	1.8	1.3
VAUGHN		50	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.8	1.8	3.5	2.0	0.5	1.6
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	5.7	3.3	2.3	2.2
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.6	5.0	4.6	1.9	2.7

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
SUN RIVER	21	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	3.0	2.6	0.9	0.6
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.4	1.8	0.2	0.3
VAUGHN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.3	2.4	0.7	0.4
		50	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.2	0.4	4.7	2.6	1.6	0.9
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.3	10.4	3.8	0.7	1.5
		90	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.5	52.4	8.0	0.4	2.2
MISSOURI	22	Average	0.6	0.4	0.7	0.2	0.3	0.3	0.3	0.3	0.5	3.1	2.9	2.0	0.9
RIVER AT		10	0.1	-0.7	-0.0	0.2	-1.3	0.5	0.5	0.2	0.7	2.7	2.5	2.1	0.6
BLACK EAGLE		20	-0.0	0.1	-0.0	0.1	0.4	0.4	0.7	0.3	0.4	3.1	5.8	1.0	0.9
DAM		50	-0.1	-0.1	0.6	0.1	0.6	0.4	0.6	0.4	1.4	5.4	4.2	3.8	1.2
		80	1.2	1.5	2.7	-0.1	-0.0	1.3	-0.0	0.2	0.7	1.7	1.6	0.8	0.9
		90	2.6	-0.1	1.1	-0.1	-0.0	-0.0	-0.0	0.1	0.7	2.3	3.0	1.5	0.9
MISSOURI	23	Average	0.5	0.4	0.7	0.2	0.2	0.3	0.3	0.3	0.5	2.9	2.7	1.9	0.8
RIVER BELOW		10	0.1	-0.7	-0.0	0.1	-1.3	0.5	0.5	0.1	0.7	2.6	2.4	2.0	0.6
MORONY		20	-0.0	0.1	-0.0	0.1	0.4	0.3	0.6	0.3	0.3	3.0	5.5	0.9	0.9
DAM		50	-0.0	-0.1	0.6	0.1	0.5	0.3	0.6	0.4	1.3	5.0	3.8	3.5	1.2
		80	1.1	1.4	2.5	-0.0	-0.0	1.2	-0.0	0.2	0.7	1.6	1.5	0.7	0.9
		90	2.4	-0.1	1.0	-0.1	-0.0	-0.0	-0.0	0.1	0.7	2.1	2.7	1.4	0.8
MISSOURI	24	Average	0.5	0.4	0.6	0.2	0.3	0.3	0.3	0.4	1.0	4.6	4.3	2.5	1.2
RIVER AT		10	-0.1	-1.3	-0.1	0.0	0.0	0.1	0.1	0.2	0.9	4.0	2.8	2.0	0.8
FORT BENTON		20	-0.0	-0.0	-0.0	0.2	0.3	0.2	0.3	0.2	0.8	3.9	3.4	2.2	0.9
		50	0.6	0.4	0.5	0.0	0.4	0.4	0.3	0.6	2.0	6.7	4.3	5.0	1.6
		80	-0.5	1.5	0.9	-0.1	0.0	1.1	-0.0	0.7	1.8	5.7	3.8	2.4	1.3
		90	-0.1	-0.1	1.8	-0.0	-0.1	-0.0	-0.0	0.4	3.5	7.8	5.9	1.8	1.7
TETON RIVER	25	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	4.6	5.1	2.7	0.8
NEAR		10	-0.9	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0	0.1	2.2	9.0	-1.1	0.4
LOMA		20	-1.9	-0.5	-0.4	-0.4	0.0	-0.1	0.0	0.3	0.5	5.3	63.4	10.5	1.3
		50	0.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.3	1.3	81.0	0.0	0.0	2.2
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.5	0.0	0.0	0.0	14.3
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARIAS RIVER	26	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	1.8	3.2	1.4	0.4
INFLOWS		10	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	1.5	1.2	0.2
TO TIBER		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.6	3.4	1.7	0.4
RESERVOIR		50	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.3	3.2	3.7	0.7
		80	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	3.3	16.8	9.8	0.9
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.4	15.4	0.0	0.0	1.2
TIBER	27	Average	-0.1	0.0	0.0	0.0	0.0	0.2	0.1	0.2	-0.8	0.7	0.7	0.7	0.1
RESERVOIR		10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.4	0.4	0.4	0.2
OUTFLOWS		20	-0.2	-0.2	-0.2	-0.2	-0.2	0.3	0.3	0.2	0.3	0.4	0.4	0.4	0.2
TO MARIAS		50	-0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.5	0.5	0.5	0.3
RIVER		80	0.3	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	1.3	1.3	1.3	0.7
		90	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	1.8	1.8	1.8	0.7
MARIAS RIVER	28	Average	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.8	1.4	5.1	4.2	2.3	1.4
NEAR		10	-0.2	-0.1	0.0	0.0	-0.1	0.2	0.0	1.0	0.3	2.2	1.8	0.7	0.6
LOMA		20	0.0	0.0	-0.1	-0.1	0.0	0.3	0.2	0.6	2.0	3.4	1.9	1.9	1.1
		50	-0.1	0.0	0.0	-0.2	0.0	0.0	0.3	0.6	2.9	6.1	7.7	2.7	2.2
		80	0.0	0.3	0.0	0.0	0.4	0.0	0.8	1.0	12.1	10.6	8.1	5.9	4.2
		90	0.0	0.3	1.0	0.9	0.6	0.0	0.4	4.9	17.1	24.6	13.1	11.1	6.7

Combination alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
MISSOURI	29	Average	0.5	0.3	0.6	0.2	0.2	0.3	0.3	0.5	1.2	5.5	5.1	2.8	1.4
RIVER AT		10	-0.1	-0.2	0.0	0.2	-0.7	0.1	0.4	0.2	1.1	4.4	3.3	2.0	1.0
VIRGELLE		20	-0.0	0.0	-0.0	0.1	0.2	0.9	0.2	0.3	1.2	5.2	5.0	2.9	1.3
		50	0.5	0.1	0.8	0.3	0.6	0.3	0.3	0.5	1.5	7.6	5.2	2.8	1.5
		80	0.6	1.1	0.8	-0.1	0.0	0.2	0.0	0.9	2.5	9.1	6.0	4.0	1.8
		90	1.5	-0.1	2.7	-0.0	3.8	-0.0	0.0	0.8	3.7	8.6	7.2	2.6	2.4
MOUTH	30	Average	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.7	6.0	6.4	1.5	1.5
OF JUDITH		10	-0.3	-0.2	0.0	0.0	0.0	0.0	0.0	0.4	0.5	3.9	3.5	1.2	0.8
RIVER		20	-0.4	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.8	4.2	0.3	0.8
		50	-0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	5.8	5.4	0.7	1.0
		80	-0.4	-0.4	0.0	0.0	0.0	0.0	0.0	1.7	4.8	12.7	11.3	2.5	2.6
		90	-0.9	0.0	0.0	0.0	0.0	0.0	0.0	1.6	6.4	14.3	15.0	4.2	3.3
MISSOURI	31	Average	0.4	0.3	0.5	0.2	0.2	0.2	0.3	0.5	1.1	5.2	5.2	2.7	1.3
RIVER NEAR		10	-0.1	-0.1	-0.1	0.1	-0.3	0.2	0.1	0.5	0.9	4.2	3.1	2.0	1.0
LANDUSKY		20	-0.0	-0.0	1.4	0.3	0.1	0.4	0.4	0.3	0.8	4.7	6.4	1.4	1.3
		50	0.7	-0.3	-0.1	0.3	0.5	0.2	0.3	0.2	1.8	6.2	5.4	2.4	1.4
		80	1.3	1.7	0.9	-0.1	-0.0	-0.0	0.6	1.1	2.5	10.9	6.6	3.8	2.2
		90	-0.1	0.2	-0.0	-0.1	-0.0	0.4	-0.0	0.8	4.8	9.2	8.3	6.2	2.3
MUSSELSHELL	32	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER AT		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOSBY		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BIG DRY	33	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CREEK		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEAR MOUTH		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSOURI	34	Average	0.4	0.3	0.6	0.2	0.2	0.2	0.2	0.5	1.1	4.9	5.0	2.6	1.2
RIVER INFLOWS		10	-0.1	0.0	-0.1	-0.7	-0.8	0.0	0.2	0.2	0.8	3.8	3.8	4.5	1.0
TO FORT PECK		20	-1.1	-0.5	-0.0	0.1	0.3	0.2	0.2	0.3	0.8	4.0	4.5	2.5	0.9
RESERVOIR		50	0.1	0.5	-2.2	0.7	0.3	-0.3	0.2	0.6	1.9	5.7	5.9	2.4	1.3
		80	1.7	-0.0	2.0	-0.0	-0.0	0.1	0.1	0.2	2.0	8.4	7.4	4.1	1.5
		90	0.0	1.4	3.7	-0.1	1.4	-0.0	0.2	0.6	4.2	11.9	8.8	6.4	3.0
FORT PECK	35	Average	1.3	1.4	1.3	1.4	1.4	1.4	1.3	1.4	1.6	1.2	1.3	1.5	1.4
RESERVOIR		10	1.0	1.0	0.0	0.6	0.9	1.1	1.1	1.1	1.2	0.8	-0.4	0.9	0.7
OUTFLOWS TO		20	1.2	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.3	1.0	1.1	1.3	1.2
MISSOURI RIVER		50	1.2	1.2	1.3	2.5	2.5	2.5	2.6	2.6	2.9	1.2	1.2	1.3	1.7
		80	1.7	1.7	1.8	6.6	6.3	0.0	0.0	0.0	0.0	1.2	1.2	1.2	1.7
		90	3.3	3.4	3.6	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.6	1.8	1.7

INSTREAM ALTERNATIVE

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG HOLE	1	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MELROSE		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEAVERHEAD	2	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ABOVE DILLON		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEAVERHEAD	3	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWIN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRIDGES		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOUTH OF	4	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUBY RIVER		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JEFFERSON	5	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWIN BRIDGES		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JEFFERSON	6	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THREE FORKS		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GALLATIN	7	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
RIVER NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
LOGAN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MADISON RIVER	8	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
INFLOWS		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TO HEBGEN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESERVOIR		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HEBGEN	9	Average	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESERVOIR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OUTFLOWS TO		20	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
MADISON RIVER		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MADISON RIVER	10	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
BELOW		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENNIS LAKE		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
MADSION RIVER	11	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THREE FORKS		20	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
MISSOURI	12	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
RIVER AT		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
TOSTON		20	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
		50	0.0	-0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.0	0.0
MISSOURI RIVER	13	Average	0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	0.0	0.2	1.4	2.5	0.5	0.3
INFLOWS TO		10	-0.0	-0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	0.1	0.9	1.6	0.2	0.2
CANYON FERRY		20	-0.0	-0.0	0.0	-0.0	0.0	-0.0	0.0	0.0	0.2	1.0	1.5	0.1	0.2
RESERVOIR		50	0.0	-0.0	-0.0	-0.0	0.0	0.0	-0.0	0.0	0.2	1.7	3.2	0.8	0.3
		80	-0.0	-0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	0.8	4.1	6.0	1.3	0.5
		90	-0.0	-0.0	0.0	0.0	-0.0	0.0	-0.0	0.1	0.4	4.2	10.4	1.7	0.5
CANYON FERRY	14	Average	0.2	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.9	0.3	0.7	0.3
RESERVOIR		10	0.1	0.0	-0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.9	0.6	0.6	0.2
OUTFLOWS TO		20	-0.1	0.0	-0.0	0.1	0.4	0.1	0.1	0.1	0.1	1.0	0.8	0.8	0.2
MISSOURI RIVER		50	-0.0	0.0	-0.0	0.1	0.1	0.1	0.1	0.2	0.1	1.3	0.0	0.0	0.2
		80	0.9	0.9	0.9	0.0	0.0	0.0	1.5	1.4	1.4	0.0	0.0	0.0	0.6
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HAUSER LAKE	15	Average	0.2	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.9	0.4	0.7	0.3
OUTFLOWS TO		10	0.0	-0.2	-0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.9	0.6	0.6	0.2
MISSOURI RIVER		20	-0.1	0.0	-0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.9	1.0	0.8	0.2
		50	0.2	0.2	0.0	0.1	0.1	0.1	0.1	0.2	0.2	1.4	0.0	0.4	0.2
		80	0.6	1.0	0.9	0.0	0.0	0.0	1.0	1.4	0.4	0.0	0.0	0.4	0.5
		90	0.4	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.3
MISSOURI	16	Average	0.3	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.9	0.4	0.6	0.3
RIVER		10	0.0	0.0	0.4	0.1	0.1	0.1	0.1	0.0	0.1	0.9	0.6	0.6	0.2
INFLOWS TO		20	0.0	0.1	-0.0	0.1	0.1	0.1	0.1	0.1	0.1	1.0	1.0	0.8	0.2
HOLTER LAKE		50	0.0	-0.0	0.2	0.1	0.1	0.1	0.2	0.1	0.1	1.2	0.6	0.0	0.2
		80	1.2	1.0	1.1	0.0	0.0	0.0	0.0	0.8	0.3	0.8	0.0	0.2	0.5
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
HOLTER LAKE	17	Average	0.2	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.9	0.4	0.6	0.3
OUTFLOWS		10	0.1	-0.0	1.4	0.1	0.1	0.4	0.1	0.0	0.1	0.9	0.6	0.6	0.3
TO MISSOURI		20	-0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.1	1.0	1.0	0.8	0.2
RIVER		50	0.2	0.0	-0.0	0.3	0.0	0.2	0.1	0.1	0.1	1.5	0.1	0.0	0.2
		80	1.1	0.4	0.4	0.0	0.0	0.0	0.1	1.0	0.6	1.0	0.0	0.6	0.4
		90	0.0	3.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.6	0.5
SMITH RIVER	18	Average	-0.6	0.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.3	2.0	4.3	2.2	0.6
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.1	1.2	0.2
EDEN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.3	4.0	1.2	0.2
		50	0.0	-0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.3	3.2	1.9	0.4
		80	-0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	4.7	12.5	3.2	1.3
		90	-1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	13.3	29.2	2.0	1.8
MISSOURI	19	Average	0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.2	1.3	1.0	0.8	0.3
RIVER NEAR		10	-0.0	-0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	1.0	0.5	0.2	0.2
ULM		20	-0.0	0.0	0.0	0.3	0.2	0.1	0.2	0.1	0.1	1.3	1.3	1.1	0.3
		50	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.2	1.6	0.9	0.3	0.3
		80	0.9	0.0	0.7	-0.0	-0.0	0.3	-0.0	0.1	0.6	0.9	1.0	0.4	0.4
		90	-0.1	-0.1	1.3	-0.0	-0.0	0.0	-0.0	0.0	0.4	1.1	1.2	0.8	0.3
MUDDY	20	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.4	2.4	1.7	1.6
CREEK		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.7	1.5	2.4	1.1
AT		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.4	2.6	2.4	1.8	1.3
VAUGHN		50	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.8	1.8	3.5	2.0	0.5	1.6
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	5.7	3.3	2.3	2.2
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.6	5.0	4.6	1.9	2.7
SUN RIVER	21	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.6	1.6	0.7	0.3
NEAR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.1	0.2	0.1
VAUGHN		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.2	1.5	0.6	0.2
		50	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.1	0.2	2.3	1.6	1.2	0.5
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	5.4	2.2	0.7	0.6
		90	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.8	26.2	4.9	0.4	1.3
MISSOURI	22	Average	0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.2	1.3	1.0	0.8	0.3
RIVER AT		10	0.0	-0.0	-0.0	0.0	-0.0	0.1	0.1	0.1	0.3	1.1	1.0	0.7	0.3
BLACK EAGLE		20	-0.0	0.0	-0.0	0.0	0.1	0.1	0.2	0.1	0.2	1.2	1.2	0.1	0.3
DAM		50	-0.0	-0.2	0.1	0.0	0.2	0.1	0.1	0.1	0.6	2.1	0.7	1.2	0.4
		80	0.2	0.2	0.8	-0.0	-0.0	0.3	-0.0	0.1	0.2	1.2	1.2	0.6	0.3
		90	1.7	-0.1	0.7	-0.0	-0.0	-0.0	0.0	0.1	0.5	1.1	0.9	1.5	0.5
MISSOURI	23	Average	0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.2	1.2	0.9	0.7	0.3
RIVER BELOW		10	0.0	-0.0	-0.0	0.0	-0.0	0.1	0.1	0.0	0.3	1.0	0.9	0.7	0.3
MORONY		20	-0.0	0.0	-0.0	0.0	0.1	0.1	0.2	0.1	0.2	1.1	1.1	0.1	0.2
DAM		50	-0.0	-0.2	0.1	0.0	0.2	0.1	0.1	0.1	0.6	1.9	0.7	1.1	0.4
		80	0.2	0.2	0.7	-0.0	0.0	0.3	-0.0	0.1	0.2	1.1	1.1	0.5	0.3
		90	1.5	-0.1	0.6	-0.0	-0.0	0.0	0.0	0.0	0.4	1.0	0.8	1.4	0.5
MISSOURI	24	Average	0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.2	1.2	1.0	0.7	0.3
RIVER AT		10	-0.0	-0.0	-0.0	-0.0	0.0	0.0	0.0	0.0	0.2	1.1	0.9	0.6	0.2
FORT BENTON		20	-0.0	0.0	-0.0	0.1	0.1	0.0	0.1	0.0	0.2	1.1	1.1	1.8	0.3
		50	0.3	0.1	0.2	0.0	0.1	0.1	0.1	0.1	0.1	1.8	0.9	1.6	0.4
		80	-0.3	0.2	0.2	-0.0	0.0	0.3	-0.0	0.1	0.2	2.0	1.1	0.6	0.3
		90	-0.1	-0.0	1.4	-0.0	-0.0	-0.0	-0.0	0.1	0.7	1.8	1.1	0.7	0.5

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
TETON RIVER	25	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	4.3	5.1	2.7	0.8
NEAR		10	-0.4	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.1	9.0	-1.1	0.4
LOMA		20	0.0	-0.5	-0.4	-0.4	0.0	-0.1	0.0	0.3	0.5	5.2	63.4	10.5	1.3
		50	0.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.3	1.3	78.6	0.0	0.0	2.2
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.5	0.0	0.0	0.0	14.3
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARIAS RIVER	26	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.9	0.4	0.1
INFLOWS		10	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.3	0.1
TO TIBER		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	0.4	0.1
RESERVOIR		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.9	1.4	0.1
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.0	4.2	2.4	0.2
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	4.0	0.0	0.0	0.3
TIBER	27	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.2	[illegible]
RESERVOIR		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
OUTFLOWS		20	-0.1	-0.1	-0.1	-0.1	-0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1	[illegible]
TO MARIAS		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.2	0.2	0.1
RIVER		80	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.2
		90	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.2
MARIAS RIVER	28	Average	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.4	0.9	0.7	0.4	0.2
NEAR		10	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.3	0.3	0.1	0.1
LOMA		20	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.6	0.3	0.4	0.2
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	1.0	1.0	0.6	0.4
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.2	1.8	1.9	0.9	0.8
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	3.0	4.4	2.5	2.4	1.2
MISSOURI	29	Average	0.1	0.1	0.2	0.0	0.0	0.1	0.1	0.1	0.3	1.5	1.1	0.8	0.4
RIVER AT		10	-0.1	-0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.3	1.3	1.0	0.5	0.3
VIRGELLE		20	-0.0	0.0	-0.0	0.0	0.1	0.3	0.1	0.1	0.3	1.3	1.1	0.8	0.3
		50	0.1	0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.4	2.1	0.8	0.6	0.4
		80	0.1	0.3	0.2	-0.0	0.0	0.1	0.0	0.2	0.7	2.3	1.4	1.0	0.5
		90	-0.0	-0.0	1.0	-0.0	0.0	-0.0	0.0	0.1	0.9	2.0	1.5	1.3	0.5
MOUTH	30	Average	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.4	2.5	0.7	[illegible]
OF JUDITH		10	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.5	1.3	0.5	0.3
RIVER		20	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.4	1.7	0.2	0.3
		50	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.3	2.2	0.4	0.5
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.7	4.9	3.8	1.3	1.1
		90	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	3.0	6.0	6.2	1.3	1.2
MISSOURI	31	Average	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.3	1.5	1.3	0.8	0.4
RIVER NEAR		10	0.0	-0.0	-0.0	0.0	0.0	0.1	0.0	0.1	0.3	1.3	1.0	0.5	0.3
LANDUSKY		20	0.0	-0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.2	1.4	1.1	0.5	0.3
		50	0.2	-0.1	-0.0	0.1	0.1	0.1	0.1	0.1	0.5	1.7	1.2	0.6	0.4
		80	0.4	0.9	0.2	-0.0	-0.0	-0.0	0.2	0.2	0.7	2.9	1.7	1.1	[illegible]
		90	-0.0	-0.1	-0.0	-0.0	-0.0	-0.0	0.0	0.2	1.1	2.6	2.0	2.0	[illegible]
MUSSELSHELL	32	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
RIVER AT		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
MOSBY		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]

Instream alternative (continued)

	MODEL NODE	% FLOW	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BIG DRY	33	Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CREEK		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEAR MOUTH		20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSOURI	34	Average	0.1	0.1	0.3	0.1	0.0	0.0	0.1	0.1	0.3	1.4	1.2	0.7	0.3
RIVER INFLOWS		10	-0.0	0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.1	1.0	1.3	0.3
TO FORT PECK		20	-0.1	-0.2	-0.0	0.0	0.1	0.1	0.0	0.1	0.3	0.9	1.3	0.7	0.3
RESERVOIR		50	0.0	0.1	-0.0	0.2	0.1	0.0	0.1	0.1	0.4	1.6	1.6	1.5	0.4
		80	0.5	0.0	0.6	-0.0	-0.0	0.0	0.0	0.1	0.7	2.3	1.9	1.8	0.6
		90	0.0	0.4	-0.1	-0.1	-0.0	-0.0	0.0	0.1	1.1	3.0	2.2	0.9	0.6
FORT PECK	35	Average	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.3	0.2	0.4	0.4
RESERVOIR		10	0.3	0.3	0.0	0.2	0.2	0.3	0.3	0.3	0.3	0.2	-1.4	0.3	0.1
OUTFLOWS TO		20	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.5	0.3
MISSOURI RIVER		50	0.3	0.3	0.3	1.2	1.2	1.2	1.2	1.2	1.4	0.4	0.4	0.3	0.6
		80	0.5	0.5	0.6	2.1	2.2	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.5
		90	1.1	1.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.5	0.5

Table C-4. Monthly reservoir elevations, contents, and energy produciton

BASELINE RUN

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hebgen Operations													
Contents (kaf):													
Average	299	267	263	262	265	262	258	296	339	341	336	319	292
10th%	312	269	264	263	267	276	288	334	360	372	368	351	310
20th%	304	268	263	263	266	270	278	320	357	370	351	321	303
50th%	294	267	263	262	266	261	255	300	345	329	325	313	290
80th%	292	266	262	262	265	252	236	267	314	317	323	310	280
90th%	291	265	262	262	264	248	226	258	310	314	321	304	277
Elevations (feet):													
Average	6528	6525	6524	6524	6525	6524	6524	6527	6531	6531	6531	6529	6527
10th%	6529	6525	6524	6524	6525	6525	6527	6531	6533	6534	6533	6532	6528
20th%	6528	6525	6524	6524	6525	6525	6526	6530	6533	6534	6532	6530	6528
50th%	6527	6525	6524	6524	6525	6524	6523	6528	6532	6530	6530	6529	6527
80th%	6527	6525	6524	6524	6524	6523	6522	6525	6529	6529	6530	6529	6526
90th%	6527	6525	6524	6524	6524	6523	6521	6524	6529	6529	6530	6528	6526
Madison Operations													
Energy Production (GWHr):													
Average	7	7	6	6	5	6	6	7	7	6	6	6	6
10th%	7	7	7	7	6	7	7	7	7	7	7	7	7
20th%	7	7	7	7	6	7	7	7	7	7	7	7	7
50th%	7	7	6	6	5	7	7	7	7	7	6	6	7
80th%	7	7	5	5	4	6	6	7	7	6	4	5	6
90th%	7	7	5	4	4	5	5	6	7	4	4	5	5
Toston Operations													
Energy Production (GWHr):													
Average	5	5	4	4	4	4	6	7	7	5	3	4	5
10th%	7	6	5	5	4	5	7	7	7	7	4	5	6
20th%	6	6	5	4	4	5	7	7	7	7	3	5	6
50th%	5	5	4	4	4	4	6	7	7	5	3	3	5
80th%	4	4	4	3	3	4	5	6	7	2	1	2	4
90th%	4	4	3	3	3	3	4	5	6	2	1	2	3
Average generation (mw):													
Average	7	7	6	5	5	6	8	9	10	6	4	5	6
10th%	9	9	7	6	6	7	10	10	10	10	6	7	6
20th%	8	8	6	6	6	7	10	10	10	9	5	6	8
50th%	6	7	6	5	5	6	8	10	10	7	3	5	6
80th%	5	6	5	4	5	5	7	8	10	3	2	3	5
90th%	5	6	5	4	4	4	6	7	8	3	1	3	5
Spills (kaf):													
Average	2	2	0	0	0	0	19	161	308	28	0	0	43
10th%	0	0	0	0	0	0	47	404	668	95	0	0	101
20th%	0	0	0	0	0	0	15	285	594	3	0	0	75
50th%	0	0	0	0	0	0	0	106	290	0	0	0	33
80th%	0	0	0	0	0	0	0	0	2	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

Baseline run (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Canyon Ferry Operations													
Energy Production (GWHr):													
Average	34	34	35	30	28	35	33	35	35	30	24	25	32
10th%	40	41	45	43	38	44	41	45	43	45	39	38	42
20th%	40	41	43	40	34	43	40	43	43	45	32	32	40
50th%	37	35	36	30	28	37	36	39	41	31	19	21	32
80th%	28	27	28	22	21	23	21	22	21	19	18	20	22
90th%	21	21	22	21	20	21	18	18	17	17	16	17	19
Contents (kaf):													
Average	1616	1629	1571	1520	1484	1424	1410	1552	1845	1789	1659	1613	1593
10th%	1808	1812	1746	1731	1750	1711	1766	1862	1947	1912	1824	1796	1805
20th%	1765	1788	1699	1652	1629	1623	1617	1787	1947	1912	1799	1747	1747
50th%	1703	1705	1644	1569	1554	1471	1428	1584	1947	1912	1759	1714	1666
80th%	1592	1594	1566	1499	1381	1272	1223	1375	1928	1768	1652	1608	1538
90th%	1262	1254	1236	1212	1168	1190	1035	1230	1660	1528	1383	1267	1285
Elevations (feet):													
Average	3786	3786	3784	3782	3781	3779	3779	3784	3793	3791	3787	3785	3785
10th%	3793	3793	3791	3790	3791	3789	3791	3794	3797	3796	3793	3792	3792
20th%	3791	3792	3789	3788	3787	3787	3787	3792	3797	3796	3792	3791	3791
50th%	3789	3789	3787	3785	3784	3782	3780	3785	3797	3796	3791	3790	3788
80th%	3786	3786	3785	3783	3779	3775	3773	3778	3796	3791	3788	3786	3784
90th%	3774	3774	3773	3772	3770	3771	3765	3773	3788	3784	3779	3774	3775
Spills (kaf):													
Average	6	5	3	1	1	34	49	55	43	36	0	0	19
10th%	21	15	12	0	0	117	154	176	168	109	0	0	64
20th%	10	4	0	0	0	71	113	134	77	21	0	0	36
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Hauser Operations													
Energy Production (GWHr):													
Average	12	12	12	11	10	12	12	12	12	11	10	10	11
10th%	13	13	13	13	12	13	13	13	13	13	13	13	13
20th%	13	13	13	13	12	13	13	13	13	13	13	13	13
50th%	13	13	13	12	11	13	13	13	13	12	8	9	12
80th%	11	11	11	8	8	9	9	9	8	8	8	8	9
90th%	9	8	9	8	8	8	8	8	8	8	8	8	8
Holter Operations													
Energy Production (GWHr):													
Average	26	25	27	24	23	29	30	31	30	25	20	21	26
10th%	31	31	33	33	31	42	40	42	40	42	30	30	36
20th%	30	29	31	31	29	39	40	42	40	34	25	26	33
50th%	27	26	28	23	22	30	31	32	31	22	17	19	26
80th%	21	21	22	17	17	18	21	20	19	16	15	16	19
90th%	16	16	19	16	15	16	16	15	16	15	15	15	16

Baseline run (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tiber Operations													
Contents (kaf):													
Average	807	783	753	721	698	710	735	845	979	967	913	857	814
10th%	881	843	795	746	699	756	816	933	1266	1220	1110	1014	923
20th%	853	818	779	736	699	729	772	908	1023	1031	981	916	854
50th%	803	778	751	724	699	698	728	846	967	945	891	834	805
80th%	749	741	718	702	699	684	689	770	876	855	804	775	755
90th%	720	712	704	694	699	669	672	733	793	788	758	726	722
Elevations (feet):													
Average	2970	2965	2964	2964	2964	2964	2964	2977	2991	2989	2985	2976	2973
10th%	2988	2964	2964	2964	2964	2964	2964	2991	3008	3006	3001	2996	2981
20th%	2986	2964	2964	2964	2964	2964	2964	2990	2996	2996	2994	2990	2978
50th%	2964	2964	2964	2964	2964	2964	2964	2975	2993	2992	2989	2964	2971
80th%	2964	2964	2964	2964	2964	2963	2963	2964	2988	2982	2964	2964	2967
90th%	2964	2964	2964	2963	2964	2963	2963	2964	2964	2964	2964	2964	2964
MPC's Great Falls Facilities Operations													
Black Eagle Energy Production GWHr):													
Average	13	13	13	12	11	13	13	13	13	12	11	11	12
10th%	14	13	14	14	12	14	13	14	13	14	14	13	14
20th%	14	13	14	14	12	14	13	14	13	14	14	13	14
50th%	14	13	14	13	12	14	13	14	13	14	11	11	13
80th%	12	12	13	10	9	11	13	14	13	10	9	10	11
90th%	10	9	10	9	8	10	10	14	13	9	8	9	10
Rainbow Energy Production (GWHr):													
Average	25	24	25	23	21	24	24	26	25	23	22	22	24
10th%	26	25	26	26	24	26	25	26	25	26	26	25	26
20th%	26	25	26	26	24	26	25	26	25	26	26	25	26
50th%	26	25	26	25	24	26	25	26	25	26	21	21	25
80th%	23	22	24	19	18	21	25	26	25	19	17	18	22
90th%	20	18	19	17	16	19	20	26	24	17	16	17	19
Cochrane Energy Production (GWHr):													
Average	26	24	25	23	22	29	31	37	36	27	21	21	27
10th%	32	31	30	31	29	42	41	42	41	42	30	29	35
20th%	30	29	29	29	27	38	40	42	41	40	27	26	33
50th%	26	24	25	22	21	29	32	42	41	26	18	19	27
80th%	20	20	21	17	16	19	23	30	28	16	15	16	20
90th%	18	16	16	15	14	17	17	26	21	15	14	15	17
Ryan Energy Production (GWHr):													
Average	41	39	40	37	35	41	41	43	42	38	35	34	39
10th%	45	43	45	45	40	45	43	45	43	45	45	43	44
20th%	45	43	45	45	40	45	43	45	43	45	45	43	44
50th%	45	42	44	39	36	45	43	45	43	45	32	33	41
80th%	36	34	37	30	28	33	40	45	43	29	27	28	34
90th%	31	27	29	26	25	30	31	44	38	26	25	26	30
Morony Energy Production (GWHr):													
Average	27	25	26	24	23	29	30	33	32	26	22	22	27
10th%	33	33	32	33	31	36	34	36	34	36	32	30	33
20th%	31	30	30	31	29	36	34	36	34	36	28	27	32
50th%	27	25	26	23	22	31	34	36	34	27	19	20	27
80th%	21	21	22	18	17	20	24	31	30	17	16	17	21
90th%	18	16	17	16	15	18	18	27	23	15	15	16	18

Baseline run (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Fort Peck Operations													
Energy Production (GWHr):													
Average	85	93	119	82	73	61	56	61	72	116	103	95	85
10th%	109	120	147	138	120	96	86	97	121	143	127	119	119
20th%	102	112	146	124	110	89	79	89	111	136	121	111	111
50th%	84	92	121	74	66	54	48	53	61	116	103	94	80
80th%	67	73	95	39	34	32	32	32	33	97	85	77	58
90th%	60	65	83	32	32	32	32	32	32	87	76	70	53
Contents (kaf):													
Average	16766	16526	16050	15910	15894	16325	16689	17193	17760	17600	17260	16976	16746
10th%	17250	16937	16345	16272	16450	16874	17204	17657	17910	18088	17795	17441	17185
20th%	17087	16842	16245	16189	16326	16726	17093	17545	17902	17857	17528	17265	17050
50th%	16779	16566	16027	15993	16041	16442	16719	17196	17868	17604	17302	16982	16793
80th%	16489	16278	15897	15617	15517	15878	16243	16849	17688	17357	16949	16640	16450
90th%	16217	16051	15769	15411	15064	15601	15935	16594	17241	17019	16696	16443	16170
Elevations (feet):													
Average	2242	2241	2239	2238	2238	2240	2242	2244	2246	2246	2244	2243	2242
10th%	2244	2243	2240	2240	2241	2242	2244	2246	2247	2248	2246	2245	2244
20th%	2243	2242	2240	2239	2240	2242	2243	2245	2247	2247	2245	2244	2243
50th%	2242	2241	2239	2239	2239	2241	2242	2244	2247	2246	2244	2243	2242
80th%	2241	2240	2238	2237	2236	2238	2240	2242	2246	2245	2243	2241	2241
90th%	2240	2239	2238	2236	2234	2237	2238	2241	2244	2243	2242	2241	2239
Spills (kaf):													
Average	0	0	0	0	0	7	5	7	14	0	10	0	4
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

CONSUMPTIVE USE ALTERNATIVE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hebgen Operations													
Contents (kaf):													
Average	299	267	263	262	265	262	258	296	339	341	336	319	292
10th%	312	269	264	263	267	276	288	334	360	372	368	351	310
20th%	304	268	263	263	266	270	278	320	357	370	351	321	303
50th%	294	267	263	262	266	261	255	300	345	329	325	313	290
80th%	292	266	262	262	265	252	236	267	314	317	323	310	280
90th%	291	265	262	262	264	248	226	258	310	314	321	304	277
Elevations (feet):													
Average	6528	6525	6524	6524	6525	6524	6524	6527	6531	6531	6531	6529	6527
10th%	6529	6525	6524	6524	6525	6525	6527	6531	6533	6534	6533	6532	6528
20th%	6528	6525	6524	6524	6525	6525	6526	6530	6533	6534	6532	6530	6528
50th%	6527	6525	6524	6524	6525	6524	6523	6528	6532	6530	6530	6529	6527
80th%	6527	6525	6524	6524	6524	6523	6522	6525	6529	6529	6530	6529	6526
90th%	6527	6525	6524	6524	6524	6523	6521	6524	6529	6529	6530	6528	6526
Madison Operations													
Energy Production (GWHr):													
Average	7	7	6	6	5	6	6	7	7	6	6	6	6
10th%	7	7	7	7	6	7	7	7	7	7	7	7	7
20th%	7	7	7	7	6	7	7	7	7	7	7	7	7
50th%	7	7	6	6	5	7	7	7	7	7	6	6	7
80th%	7	7	5	5	4	6	6	7	7	6	4	5	6
90th%	7	7	5	4	4	5	5	6	7	4	4	5	5
Toston Operations													
Energy Production (GWHr):													
Average	5	5	4	4	4	4	6	7	7	5	2	3	5
10th%	7	6	5	5	4	5	7	7	7	7	4	5	6
20th%	6	6	5	4	4	5	7	7	7	7	3	5	6
50th%	5	5	4	4	4	4	6	7	7	5	2	3	5
80th%	4	4	4	3	3	4	5	6	7	2	1	2	4
90th%	4	4	3	3	3	3	4	5	6	2	1	2	3
Average generation (mw):													
Average	7	7	6	5	5	6	8	9	10	6	3	5	6
10th%	9	9	7	6	6	7	10	10	10	10	5	7	8
20th%	8	8	6	6	6	7	10	10	10	9	4	6	8
50th%	6	7	6	5	5	6	8	10	10	6	3	5	6
80th%	5	6	5	4	5	5	7	8	10	3	2	3	5
90th%	5	6	5	4	4	4	6	7	8	2	1	3	5
Spills (kaf):													
Average	2	2	0	0	0	0	19	161	302	24	0	0	42
10th%	0	0	0	0	0	0	47	404	664	73	0	0	99
20th%	0	0	0	0	0	0	15	284	580	0	0	0	73
50th%	0	0	0	0	0	0	0	106	281	0	0	0	32
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

Consumptive use alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Canyon Ferry Operations													
Energy Production (GWHr):													
Average	33	33	34	30	27	35	33	35	35	28	22	24	31
10th%	40	41	45	42	38	44	42	45	43	45	36	37	41
20th%	40	41	43	40	35	42	40	43	43	43	29	31	39
50th%	37	35	36	29	26	38	36	39	41	26	19	20	32
80th%	23	25	25	22	21	23	21	19	19	18	18	19	21
90th%	20	20	20	19	19	20	18	16	16	16	15	18	18
Contents (kaf):													
Average	1577	1594	1541	1493	1462	1405	1395	1539	1822	1753	1611	1567	1563
10th%	1786	1805	1735	1732	1758	1712	1776	1870	1947	1912	1813	1760	1800
20th%	1761	1782	1694	1640	1627	1606	1618	1802	1947	1912	1791	1723	1742
50th%	1687	1681	1633	1566	1543	1426	1423	1559	1947	1901	1739	1714	1652
80th%	1468	1535	1523	1433	1364	1270	1172	1364	1814	1718	1564	1470	1475
90th%	1153	1145	1127	1103	1059	1114	1043	1234	1537	1406	1228	1158	1192
Elevations (feet):													
Average	3784	3785	3783	3781	3780	3778	3778	3783	3792	3790	3785	3784	3784
10th%	3792	3792	3790	3790	3791	3790	3792	3794	3797	3796	3793	3791	3792
20th%	3791	3792	3789	3787	3787	3786	3787	3792	3797	3796	3792	3790	3790
50th%	3789	3789	3787	3785	3784	3780	3780	3785	3797	3795	3790	3790	3788
80th%	3782	3784	3783	3780	3778	3775	3771	3778	3793	3790	3785	3782	3782
90th%	3770	3770	3769	3768	3766	3769	3766	3773	3784	3779	3773	3770	3771
Spills (kaf):													
Average	5	5	2	1	1	33	47	54	42	29	0	0	18
10th%	20	14	9	0	0	116	151	170	164	71	0	0	60
20th%	10	5	0	0	0	64	106	128	75	4	0	0	33
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Hauser Operations													
Energy Production (GWHr):													
Average	12	11	12	11	10	12	12	12	12	10	9	10	11
10th%	13	13	13	13	12	13	13	13	13	13	13	13	13
20th%	13	13	13	13	12	13	13	13	13	13	12	12	13
50th%	13	13	13	11	10	13	13	13	13	10	8	9	12
80th%	9	10	10	8	8	9	9	9	8	8	8	8	9
90th%	8	8	9	8	8	8	8	8	8	8	8	8	8
Holter Operations													
Energy Production (GWHr):													
Average	25	25	26	24	22	29	29	31	30	23	19	20	25
10th%	31	31	32	33	31	42	40	42	40	42	28	28	35
20th%	30	29	31	31	28	39	39	42	40	31	23	24	32
50th%	26	26	28	23	21	30	30	32	31	20	17	18	25
80th%	18	20	20	17	17	18	21	18	19	16	15	16	18
90th%	16	15	18	16	15	16	16	15	16	15	14	15	15

Consumptive use alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tiber Operations													
Contents (kaf):													
Average	807	783	753	721	698	710	735	846	978	965	911	855	813
10th%	881	843	795	746	699	756	817	933	1266	1218	1109	1012	923
20th%	854	818	779	736	699	729	772	908	1022	1030	979	914	853
50th%	803	778	751	724	699	698	728	846	967	944	890	833	805
80th%	749	741	718	702	699	684	690	770	875	854	803	774	755
90th%	720	711	704	694	699	669	673	733	792	786	755	723	721
Elevations (feet):													
Average	2970	2965	2964	2964	2964	2964	2964	2977	2991	2989	2985	2976	2973
10th%	2988	2964	2964	2964	2964	2964	2964	2991	3008	3006	3000	2995	2981
20th%	2986	2964	2964	2964	2964	2964	2964	2990	2996	2996	2994	2990	2978
50th%	2964	2964	2964	2964	2964	2964	2964	2975	2993	2992	2989	2964	2971
80th%	2964	2964	2964	2964	2964	2963	2963	2964	2988	2982	2964	2964	2967
90th%	2964	2964	2964	2963	2964	2963	2963	2964	2964	2964	2964	2964	2964
MPC's Great Falls Facilities Operations													
Black Eagle Energy Production (GWHr):													
Average	13	12	13	12	11	13	13	13	13	12	11	11	12
10th%	14	13	14	14	12	14	13	14	13	14	14	13	14
20th%	14	13	14	14	12	14	13	14	13	14	14	13	14
50th%	14	13	14	13	12	14	13	14	13	14	10	11	13
80th%	12	11	12	10	9	11	13	14	13	9	9	9	11
90th%	10	9	10	9	8	10	10	14	13	8	8	9	10
Rainbow Energy Production (GWHr):													
Average	25	24	24	23	21	24	24	26	25	23	21	21	23
10th%	26	25	26	26	24	26	25	26	25	26	26	25	26
20th%	26	25	26	26	24	26	25	26	25	26	26	25	26
50th%	26	25	26	25	23	26	25	26	25	26	20	20	25
80th%	23	22	23	19	18	21	25	26	25	17	17	18	21
90th%	19	18	19	17	16	19	20	26	24	16	15	17	19
Cochrane Energy Production (GWHr):													
Average	25	24	24	23	21	29	31	37	36	26	19	20	26
10th%	32	31	30	31	29	41	41	42	41	42	29	27	35
20th%	30	28	29	29	27	37	40	42	41	37	24	25	33
50th%	26	24	25	22	20	29	31	42	41	23	17	18	27
80th%	20	19	20	17	16	18	23	30	27	15	15	16	20
90th%	17	16	16	15	14	17	17	26	21	14	13	15	17
Ryan Energy Production (GWHr):													
Average	41	39	40	37	35	40	41	43	42	37	33	34	38
10th%	45	43	45	45	40	45	43	45	43	45	45	43	44
20th%	45	43	45	45	40	45	43	45	43	45	42	43	44
50th%	45	42	43	39	36	45	43	45	43	40	30	31	40
80th%	35	33	35	29	27	32	40	45	43	27	26	28	33
90th%	29	27	28	26	24	30	31	44	37	24	23	26	29
Morony Energy Production (GWHr):													
Average	26	25	25	24	22	29	29	33	32	25	20	21	26
10th%	33	33	32	33	31	36	34	36	34	36	30	28	33
20th%	31	30	30	31	28	36	34	36	34	36	25	26	31
50th%	27	25	26	23	21	31	33	36	34	24	18	19	26
80th%	21	20	21	17	16	19	24	31	29	16	15	16	21
90th%	18	16	17	16	15	18	18	27	22	15	14	15	18

Consumptive use alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Fort Peck Operations													
Energy Production (GWHr):													
Average	82	90	115	79	71	59	54	59	69	113	100	92	82
10th%	107	118	147	137	120	94	85	95	119	140	125	116	117
20th%	99	109	143	121	107	86	77	87	107	133	118	107	108
50th%	82	89	117	71	63	51	45	50	58	113	100	91	77
80th%	64	70	91	34	32	32	32	32	33	94	83	74	56
90th%	56	61	78	32	32	32	32	32	32	83	73	67	51
Contents (kaf):													
Average	16674	16448	15998	15874	15872	16312	16682	17186	17740	17526	17156	16871	16695
10th%	17127	16867	16309	16239	16461	16872	17225	17668	17908	18020	17655	17315	17139
20th%	17002	16766	16213	16153	16307	16729	17104	17557	17900	17799	17422	17138	17007
50th%	16708	16485	15983	15956	16024	16427	16704	17206	17865	17548	17210	16869	16749
80th%	16395	16207	15835	15577	15479	15867	16204	16825	17607	17269	16855	16539	16388
90th%	16067	15937	15684	15364	15036	15580	15925	16540	17176	16938	16534	16232	16084
Elevations (feet):													
Average	2242	2241	2239	2238	2238	2240	2242	2244	2246	2245	2244	2242	2242
10th%	2244	2242	2240	2240	2241	2242	2244	2246	2247	2247	2246	2244	2244
20th%	2243	2242	2240	2239	2240	2242	2243	2245	2247	2246	2245	2244	2243
50th%	2242	2241	2239	2238	2239	2241	2242	2244	2247	2245	2244	2242	2242
80th%	2240	2240	2238	2237	2236	2238	2240	2242	2246	2244	2242	2241	2240
90th%	2239	2238	2237	2236	2234	2237	2238	2241	2244	2243	2241	2240	2239
Spills (kaf):													
Average	0	0	0	0	0	6	5	6	13	0	9	0	3
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBINATION ALTERNATIVE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hebgen Operations													
Contents (kaf):													
Average	299	267	263	262	265	262	258	296	339	341	336	319	292
10th%	312	269	264	263	267	276	288	334	360	372	368	351	310
20th%	304	268	263	263	266	270	278	320	357	370	351	321	303
50th%	294	267	263	262	266	261	255	300	345	329	325	313	290
80th%	292	266	262	262	265	252	236	267	314	317	323	310	280
90th%	291	265	262	262	264	248	226	258	310	314	321	304	277
Elevations (feet):													
Average	6528	6525	6524	6524	6525	6524	6524	6527	6531	6531	6531	6529	6527
10th%	6529	6525	6524	6524	6525	6525	6527	6531	6533	6534	6533	6532	6528
20th%	6528	6525	6524	6524	6525	6525	6526	6530	6533	6534	6532	6530	6528
50th%	6527	6525	6524	6524	6525	6524	6523	6528	6532	6530	6530	6529	6527
80th%	6527	6525	6524	6524	6524	6523	6522	6525	6529	6529	6530	6529	6526
90th%	6527	6525	6524	6524	6524	6523	6521	6524	6529	6529	6530	6528	6526
Madison Operations													
Energy Production (GWHr):													
Average	7	7	6	6	5	6	6	7	7	6	6	6	6
10th%	7	7	7	7	6	7	7	7	7	7	7	7	7
20th%	7	7	7	7	6	7	7	7	7	7	7	7	7
50th%	7	7	6	6	5	7	7	7	7	7	6	6	7
80th%	7	7	5	5	4	6	6	7	7	6	4	5	6
90th%	7	7	5	4	4	5	5	6	7	4	4	5	5
Toston Operations													
Energy Production (GWHr):													
Average	5	5	4	4	4	4	6	7	7	5	2	4	5
10th%	7	6	5	5	4	5	7	7	7	7	4	5	6
20th%	6	6	5	4	4	5	7	7	7	7	3	5	6
50th%	5	5	4	4	4	4	6	7	7	5	2	3	5
80th%	4	4	4	3	3	4	5	6	7	2	1	2	4
90th%	4	4	3	3	3	3	4	5	6	2	1	2	3
Average generation (mw):													
Average	7	7	6	5	5	6	8	9	10	6	3	5	6
10th%	9	9	7	6	6	7	10	10	10	10	5	7	8
20th%	8	8	6	6	6	7	10	10	10	9	4	6	8
50th%	6	7	6	5	5	6	8	10	10	6	3	5	6
80th%	5	6	5	4	5	5	7	8	10	3	2	3	5
90th%	5	6	5	4	4	4	6	7	8	2	1	3	5
Spills (kaf):													
Average	2	2	0	0	0	0	19	161	305	26	0	0	43
10th%	0	0	0	0	0	0	47	404	666	85	0	0	100
20th%	0	0	0	0	0	0	15	285	588	0	0	0	74
50th%	0	0	0	0	0	0	0	106	286	0	0	0	33
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

Combination alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Canyon Ferry Operations													
Energy Production (GWHr):													
Average	34	33	35	30	28	35	33	35	35	29	23	25	31
10th%	40	41	45	42	38	44	42	45	43	45	38	37	42
20th%	40	41	43	40	35	42	40	43	43	45	31	32	40
50th%	37	35	36	30	27	38	36	39	41	29	19	20	32
80th%	27	26	27	22	21	23	21	19	19	19	18	19	22
90th%	21	20	20	20	20	20	19	17	17	17	16	17	19
Contents (kaf):													
Average	1601	1615	1560	1510	1475	1416	1404	1547	1837	1776	1640	1595	1581
10th%	1801	1808	1742	1731	1746	1711	1770	1865	1947	1912	1813	1784	1803
20th%	1773	1787	1695	1642	1627	1617	1618	1793	1947	1912	1796	1736	1745
50th%	1696	1696	1639	1571	1550	1482	1427	1581	1947	1908	1752	1714	1664
80th%	1559	1578	1556	1479	1379	1264	1214	1376	1921	1754	1619	1569	1522
90th%	1219	1211	1193	1169	1125	1166	1037	1231	1620	1501	1341	1224	1253
Elevations (feet):													
Average	3785	3785	3784	3782	3781	3779	3778	3783	3793	3791	3786	3785	3784
10th%	3792	3793	3790	3790	3791	3790	3791	3794	3797	3796	3793	3792	3792
20th%	3791	3792	3789	3787	3787	3787	3787	3792	3797	3796	3792	3790	3791
50th%	3789	3789	3787	3785	3784	3782	3780	3785	3797	3796	3791	3790	3788
80th%	3785	3785	3785	3782	3779	3774	3772	3778	3796	3791	3787	3785	3783
90th%	3772	3772	3771	3771	3769	3770	3765	3773	3787	3783	3777	3773	3774
Spills (kaf):													
Average	6	5	2	1	1	34	48	55	43	33	0	0	19
10th%	21	14	10	0	0	120	153	171	168	94	0	0	63
20th%	12	5	0	0	0	64	110	132	76	9	0	0	34
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Hauser Operations													
Energy Production (GWHr):													
Average	12	12	12	11	10	12	12	12	12	11	10	10	11
10th%	13	13	13	13	12	13	13	13	13	13	13	13	13
20th%	13	13	13	13	12	13	13	13	13	13	12	12	13
50th%	13	13	13	11	11	13	13	13	13	11	8	9	12
80th%	10	10	11	8	8	9	9	9	8	8	8	8	9
90th%	9	8	9	8	8	8	8	8	8	8	8	8	8
Holter Operations													
Energy Production (GWHr):													
Average	26	25	27	24	23	29	30	31	30	24	20	20	26
10th%	31	31	32	33	31	42	40	42	40	42	29	29	35
20th%	30	29	31	31	28	39	39	42	40	33	24	25	33
50th%	27	26	28	23	22	30	30	32	31	21	17	18	25
80th%	20	20	21	17	17	18	21	19	19	16	15	16	18
90th%	16	15	18	16	15	16	16	15	16	15	14	15	16

Combination alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tiber Operations													
Contents (kaf):													
Average	807	783	753	721	698	710	735	846	978	965	911	855	813
10th%	881	843	795	746	699	756	816	933	1266	1219	1109	1013	923
20th%	854	818	779	736	699	729	772	908	1023	1030	980	915	854
50th%	803	778	751	724	699	698	728	846	967	944	890	833	805
80th%	749	741	718	702	699	684	689	770	875	854	803	774	755
90th%	720	711	704	694	699	669	672	733	792	787	756	724	722
Elevations (feet):													
Average	2970	2965	2964	2964	2964	2964	2964	2977	2991	2989	2985	2976	2973
10th%	2988	2964	2964	2964	2964	2964	2964	2991	3008	3006	3000	2995	2981
20th%	2986	2964	2964	2964	2964	2964	2964	2990	2996	2996	2994	2990	2978
50th%	2964	2964	2964	2964	2964	2964	2964	2975	2993	2992	2989	2964	2971
80th%	2964	2964	2964	2964	2964	2963	2963	2964	2988	2982	2964	2964	2967
90th%	2964	2964	2964	2963	2964	2963	2963	2964	2964	2964	2964	2964	2964
MPC's Great Falls Facilities Operations													
Black Eagle Energy Production (GWHr):													
Average	13	12	13	12	11	13	13	13	13	12	11	11	12
10th%	14	13	14	14	12	14	13	14	13	14	14	13	14
20th%	14	13	14	14	12	14	13	14	13	14	14	13	14
50th%	14	13	14	13	12	14	13	14	13	14	10	11	13
80th%	12	12	12	10	9	11	13	14	13	9	9	9	11
90th%	10	9	10	9	8	10	10	14	13	8	8	9	10
Rainbow Energy Production (GWHr):													
Average	25	24	24	23	21	24	24	26	25	23	21	21	23
10th%	26	25	26	26	24	26	25	26	25	26	26	25	26
20th%	26	25	26	26	24	26	25	26	25	26	26	25	26
50th%	26	25	26	25	24	26	25	26	25	26	20	21	25
80th%	23	22	23	19	18	21	25	26	25	18	17	18	21
90th%	20	18	19	17	16	19	20	26	24	16	16	17	19
Cochrane Energy Production (GWHr):													
Average	26	24	24	23	22	29	31	37	36	27	20	20	27
10th%	32	31	30	31	29	42	41	42	41	42	30	28	35
20th%	30	29	29	29	27	37	40	42	41	39	25	25	33
50th%	26	24	25	22	21	29	32	42	41	25	18	18	27
80th%	20	19	20	17	16	18	23	30	28	16	15	16	20
90th%	17	16	16	15	14	17	17	26	21	14	14	15	17
Ryan Energy Production (GWHr):													
Average	41	39	40	37	35	41	41	43	42	38	34	34	39
10th%	45	43	45	45	40	45	43	45	43	45	45	43	44
20th%	45	43	45	45	40	45	43	45	43	45	44	43	44
50th%	45	42	44	39	36	45	43	45	43	43	31	32	41
80th%	35	34	36	30	28	32	40	45	43	28	26	28	34
90th%	30	27	28	26	25	30	31	44	37	25	24	26	30
Morony Energy Production (GWHr):													
Average	27	25	26	24	23	29	29	33	32	26	21	21	26
10th%	33	33	32	33	31	36	34	36	34	36	31	29	33
20th%	31	30	30	31	28	36	34	36	34	36	26	27	32
50th%	27	25	26	23	22	31	33	36	34	26	18	19	27
80th%	21	20	22	18	17	19	24	31	29	17	16	17	21
90th%	18	16	17	16	15	18	18	27	22	15	15	16	18

Combination alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Fort Peck Operations													
Energy Production (GWHr):													
Average	84	92	117	81	72	60	55	60	71	115	102	94	84
10th%	108	119	147	137	119	95	85	96	120	142	127	117	118
20th%	101	111	145	123	109	88	78	88	109	134	120	109	110
50th%	83	91	120	73	64	52	47	51	60	115	102	92	79
80th%	66	72	93	36	32	32	32	32	33	96	84	76	57
90th%	58	62	81	32	32	32	32	32	32	85	75	69	52
Contents (kaf):													
Average	16727	16493	16024	15892	15883	16318	16685	17189	17752	17569	17217	16931	16723
10th%	17196	16897	16327	16259	16455	16873	17213	17661	17909	18067	17753	17379	17166
20th%	17052	16804	16216	16176	16322	16725	17097	17547	17902	17832	17481	17216	17031
50th%	16748	16536	15993	15975	16034	16439	16709	17200	17867	17582	17264	16937	16774
80th%	16451	16248	15873	15589	15502	15878	16229	16847	17643	17326	16911	16599	16425
90th%	16146	16009	15729	15392	15053	15592	15931	16569	17221	16981	16648	16394	16139
Elevations (feet):													
Average	2242	2241	2239	2238	2238	2240	2242	2244	2246	2245	2244	2243	2242
10th%	2244	2243	2240	2240	2241	2242	2244	2246	2247	2247	2246	2245	2244
20th%	2243	2242	2240	2239	2240	2242	2243	2245	2247	2246	2245	2244	2243
50th%	2242	2241	2239	2238	2239	2241	2242	2244	2247	2245	2244	2243	2242
80th%	2241	2240	2238	2237	2236	2238	2240	2242	2246	2244	2243	2241	2240
90th%	2239	2239	2237	2236	2234	2237	2238	2241	2244	2243	2241	2240	2239
Spills (kaf):													
Average	0	0	0	0	0	7	5	7	14	0	9	0	4
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

INSTREAM ALTERNATIVE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hebgen Operations													
Contents (kaf):													
Average	299	267	263	262	265	262	258	296	339	341	336	319	292
10th%	312	269	264	263	267	276	288	334	360	372	368	351	310
20th%	304	268	263	263	266	270	278	320	357	370	351	321	303
50th%	294	267	263	262	266	261	255	300	345	329	325	313	290
80th%	292	266	262	262	265	252	236	267	314	317	323	310	280
90th%	291	265	262	262	264	248	226	258	310	314	321	304	277
Elevations (feet):													
Average	6528	6525	6524	6524	6525	6524	6524	6527	6531	6531	6531	6529	6527
10th%	6529	6525	6524	6524	6525	6525	6527	6531	6533	6534	6533	6532	6528
20th%	6528	6525	6524	6524	6525	6525	6526	6530	6533	6534	6532	6530	6528
50th%	6527	6525	6524	6524	6525	6524	6523	6528	6532	6530	6530	6529	6527
80th%	6527	6525	6524	6524	6524	6523	6522	6525	6529	6529	6530	6529	6526
90th%	6527	6525	6524	6524	6524	6523	6521	6524	6529	6529	6530	6528	6526
Madison Operations													
Energy Production (GWHr):													
Average	7	7	6	6	5	6	6	7	7	6	6	6	6
10th%	7	7	7	7	6	7	7	7	7	7	7	7	7
20th%	7	7	7	7	6	7	7	7	7	7	7	7	7
50th%	7	7	6	6	5	7	7	7	7	7	6	6	7
80th%	7	7	5	5	4	6	6	7	7	6	4	5	6
90th%	7	7	5	4	4	5	5	6	7	4	4	5	5
Toston Operations													
Energy Production (GWHr):													
Average	5	5	4	4	4	4	6	7	7	5	3	4	5
10th%	7	6	5	5	4	5	7	7	7	7	4	5	6
20th%	6	6	5	4	4	5	7	7	7	7	3	5	6
50th%	5	5	4	4	4	4	6	7	7	5	3	3	5
80th%	4	4	4	3	3	4	5	6	7	2	1	2	4
90th%	4	4	3	3	3	3	4	5	6	2	1	2	3
Average generation (mw):													
Average	7	7	6	5	5	6	8	9	10	6	4	5	6
10th%	9	9	7	6	6	7	10	10	10	10	6	7	8
20th%	8	8	6	6	6	7	10	10	10	9	5	6	8
50th%	6	7	6	5	5	6	8	10	10	7	3	5	6
80th%	5	6	5	4	5	5	7	8	10	3	2	3	5
90th%	5	6	5	4	4	4	6	7	8	3	1	3	5
Spills (kaf):													
Average	2	2	0	0	0	0	19	161	308	28	0	0	43
10th%	0	0	0	0	0	0	47	404	668	95	0	0	101
20th%	0	0	0	0	0	0	15	285	594	3	0	0	75
50th%	0	0	0	0	0	0	0	106	290	0	0	0	33
80th%	0	0	0	0	0	0	0	0	2	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

Instream alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Canyon Ferry Operations													
Energy Production (GWHr):													
Average	34	34	35	30	28	35	33	35	35	30	24	25	31
10th%	40	41	45	43	38	44	41	45	43	45	38	38	42
20th%	40	41	43	40	34	42	40	43	43	45	31	32	40
50th%	37	35	36	30	28	37	36	39	41	30	19	21	32
80th%	28	27	28	22	21	23	21	21	20	19	18	20	22
90th%	20	20	21	20	20	20	18	18	17	17	16	17	19
Contents (kaf):													
Average	1611	1624	1567	1517	1481	1422	1409	1550	1842	1785	1653	1607	1589
10th%	1806	1811	1746	1731	1749	1710	1767	1863	1947	1912	1820	1793	1805
20th%	1765	1788	1697	1650	1629	1621	1617	1788	1947	1912	1797	1743	1746
50th%	1700	1703	1642	1568	1553	1472	1427	1585	1947	1912	1757	1714	1665
80th%	1588	1592	1565	1493	1380	1269	1221	1374	1926	1763	1641	1596	1534
90th%	1251	1243	1224	1200	1156	1181	1036	1230	1655	1521	1372	1256	1277
Elevations (feet):													
Average	3785	3786	3784	3782	3781	3779	3778	3784	3793	3791	3787	3785	3785
10th%	3793	3793	3791	3790	3791	3789	3791	3794	3797	3796	3793	3792	3792
20th%	3791	3792	3789	3788	3787	3787	3787	3792	3797	3796	3792	3791	3791
50th%	3789	3789	3787	3785	3784	3782	3780	3785	3797	3796	3791	3790	3788
80th%	3786	3786	3785	3782	3779	3774	3773	3778	3796	3791	3787	3786	3784
90th%	3774	3773	3773	3772	3770	3771	3765	3773	3788	3783	3778	3774	3774
Spills (kaf):													
Average	6	5	2	1	1	33	48	55	43	35	0	0	19
10th%	22	15	11	0	0	117	154	174	168	104	0	0	64
20th%	10	4	0	0	0	69	112	133	77	18	0	0	35
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Hauser Operations													
Energy Production (GWHr):													
Average	12	12	12	11	10	12	12	12	12	11	10	10	11
10th%	13	13	13	13	12	13	13	13	13	13	13	13	13
20th%	13	13	13	13	12	13	13	13	13	13	13	13	13
50th%	13	13	13	11	11	13	13	13	13	12	8	9	12
80th%	11	11	11	8	8	9	9	9	8	8	8	8	9
90th%	9	8	9	8	8	8	8	8	8	8	8	8	8
Holter Operations													
Energy Production (GWHr):													
Average	26	25	27	24	23	29	30	31	30	25	20	21	26
10th%	31	31	32	33	31	42	40	42	40	42	30	30	35
20th%	30	29	31	31	29	39	39	42	40	34	25	25	33
50th%	27	26	28	23	22	30	30	32	31	22	17	19	26
80th%	21	21	22	17	17	18	21	20	19	16	15	16	19
90th%	16	15	19	16	15	16	16	15	16	15	15	15	16

Instream alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tiber Operations													
Contents (kaf):	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Average	807	783	753	721	698	710	735	846	979	966	913	857	814
10th%	881	843	795	746	699	756	816	933	1266	1220	1110	1013	923
20th%	854	818	779	736	699	729	772	908	1023	1031	981	916	854
50th%	803	778	751	724	699	698	728	846	967	945	891	834	805
80th%	749	741	718	702	699	684	689	770	876	855	804	775	755
90th%	720	711	704	694	699	669	672	733	793	788	757	725	722
Elevations (feet):													
Average	2970	2965	2964	2964	2964	2964	2964	2977	2991	2989	2985	2976	2973
10th%	2988	2964	2964	2964	2964	2964	2964	2991	3008	3006	3001	2996	2981
20th%	2986	2964	2964	2964	2964	2964	2964	2990	2996	2996	2994	2990	2978
50th%	2964	2964	2964	2964	2964	2964	2964	2975	2993	2992	2989	2964	2971
80th%	2964	2964	2964	2964	2964	2963	2963	2964	2988	2982	2964	2964	2967
90th%	2964	2964	2964	2963	2964	2963	2963	2964	2964	2964	2964	2964	2964
MPC's Great Falls Facilities Operations													
Black Eagle Energy Production (GWHr):													
Average	13	13	13	12	11	13	13	13	13	12	11	11	12
10th%	14	13	14	14	12	14	13	14	13	14	14	13	14
20th%	14	13	14	14	12	14	13	14	13	14	14	13	14
50th%	14	13	14	13	12	14	13	14	13	14	11	11	13
80th%	12	12	13	10	9	11	13	14	13	10	9	9	11
90th%	10	9	10	9	8	10	10	14	13	8	8	9	10
Rainbow Energy Production (GWHr):													
Average	25	24	25	23	21	24	24	26	25	23	22	21	24
10th%	26	25	26	26	24	26	25	26	25	26	26	25	26
20th%	26	25	26	26	24	26	25	26	25	26	26	25	26
50th%	26	25	26	25	24	26	25	26	25	26	21	21	25
80th%	23	22	24	19	18	21	25	26	25	18	17	18	22
90th%	20	18	19	17	16	19	20	26	24	17	16	17	19
Cochrane Energy Production (GWHr):													
Average	26	24	24	23	22	29	31	37	36	27	21	21	27
10th%	32	31	30	31	29	42	41	42	41	42	30	28	35
20th%	30	29	29	29	27	38	40	42	41	40	26	26	33
50th%	26	24	25	22	21	29	32	42	41	26	18	19	27
80th%	20	20	21	17	16	18	23	30	28	16	15	16	20
90th%	17	16	16	15	14	17	17	26	21	14	14	15	17
Ryan Energy Production (GWHr):													
Average	41	39	40	37	35	41	41	43	42	38	34	34	39
10th%	45	43	45	45	40	45	43	45	43	45	45	43	44
20th%	45	43	45	45	40	45	43	45	43	45	45	43	44
50th%	45	42	44	39	36	45	43	45	43	44	32	33	41
80th%	36	34	37	30	28	32	40	45	43	28	26	28	34
90th%	30	27	29	26	25	30	31	44	37	25	25	26	30
Morony Energy Production (GWHr):													
Average	27	25	26	24	23	29	30	33	32	26	22	21	26
10th%	33	33	32	33	31	36	34	36	34	36	32	30	33
20th%	31	30	30	31	28	36	34	36	34	36	28	27	32
50th%	27	25	26	23	22	31	33	36	34	27	19	20	27
80th%	21	21	22	18	17	19	24	31	29	17	16	17	21
90th%	18	16	17	16	15	18	18	27	22	15	15	16	18

Instream alternative (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Fort Peck Operations													
Energy Production (GWHr):													
Average	85	93	118	81	73	61	56	61	71	116	103	95	84
10th%	109	120	147	138	120	95	86	97	121	143	128	118	118
20th%	102	112	146	124	110	89	79	89	110	135	120	110	110
50th%	84	92	121	73	65	53	47	52	61	116	103	93	80
80th%	67	73	95	38	33	32	32	32	33	96	85	77	58
90th%	59	64	82	32	32	32	32	32	32	86	76	70	52
Contents (kaf):													
Average	16755	16517	16043	15904	15890	16323	16688	17192	17758	17591	17248	16963	16739
10th%	17236	16925	16340	16269	16452	16873	17207	17659	17910	18079	17784	17424	17180
20th%	17078	16833	16237	16186	16325	16724	17093	17545	17902	17849	17514	17252	17045
50th%	16769	16557	16023	15987	16038	16441	16718	17196	17867	17598	17292	16970	16788
80th%	16477	16269	15889	15608	15513	15877	16245	16848	17673	17352	16939	16632	16444
90th%	16198	16040	15757	15406	15061	15598	15934	16593	17236	17008	16683	16430	16162
Elevations (feet):													
Average	2242	2241	2239	2238	2238	2240	2242	2244	2246	2245	2244	2243	2242
10th%	2244	2243	2240	2240	2241	2242	2244	2246	2247	2248	2246	2245	2244
20th%	2243	2242	2240	2239	2240	2242	2243	2245	2247	2247	2245	2244	2243
50th%	2242	2241	2239	2239	2239	2241	2242	2244	2247	2246	2244	2243	2242
80th%	2241	2240	2238	2237	2236	2238	2240	2242	2246	2244	2243	2241	2241
90th%	2240	2239	2238	2236	2234	2237	2238	2241	2244	2243	2242	2241	2239
Spills (kaf):													
Average	0	0	0	0	0	7	5	7	14	0	10	0	4
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C-5. Reductions to monthly reservoir elevations, contents, and energy production under each alternative

BASELINE TO CONSUMPTIVE USE ALTERNATIVE (REDUCTIONS)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hebgen Operations													
Contents (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	0	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Madison Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toston Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	25.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average generation (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0
Spills (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	14.3	0.0	0.0	2.3
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	23.2	0.0	0.0	2.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.4	100.0	0.0	0.0	2.7
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	3.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Baseline to consumptive use alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Canyon Ferry Operations													
Energy Production (%):													
Average	2.9	2.9	2.9	0.0	3.6	0.0	0.0	0.0	0.0	6.7	8.3	4.0	3.1
10th%	0.0	0.0	0.0	2.3	0.0	0.0	-2.4	0.0	0.0	0.0	7.7	2.6	2.4
20th%	0.0	0.0	0.0	0.0	-2.9	2.3	0.0	0.0	0.0	4.4	9.4	3.1	2.5
50th%	0.0	0.0	0.0	3.3	7.1	-2.7	0.0	0.0	0.0	16.1	0.0	4.8	0.0
80th%	17.9	7.4	10.7	0.0	0.0	0.0	0.0	13.6	9.5	5.3	0.0	5.0	4.5
90th%	4.8	4.8	9.1	9.5	5.0	4.8	0.0	11.1	5.9	5.9	6.2	-5.9	5.3
Contents (%):													
Average	2.4	2.1	1.9	1.8	1.5	1.3	1.1	0.8	1.2	2.0	2.9	2.9	1.9
10th%	1.2	0.4	0.6	-0.1	-0.5	-0.1	-0.6	-0.4	0.0	0.0	0.6	2.0	0.3
20th%	0.2	0.3	0.3	0.7	0.1	1.0	-0.1	-0.8	0.0	0.0	0.4	1.4	0.3
50th%	0.9	1.4	0.7	0.2	0.7	3.1	0.4	1.6	0.0	0.6	1.1	0.0	0.8
80th%	7.8	3.7	2.7	4.4	1.2	0.2	4.2	0.8	5.9	2.8	5.3	8.6	4.1
90th%	8.6	8.7	8.8	9.0	9.3	6.4	-0.8	-0.3	7.4	8.0	11.2	8.6	7.2
Elevations (feet):													
Average	2	1	1	1	1	1	1	1	1	1	2	1	1
10th%	1	1	1	0	0	-1	-1	0	0	0	0	1	0
20th%	0	0	0	1	0	1	0	0	0	0	0	1	1
50th%	0	0	0	0	0	2	0	0	0	1	1	0	0
80th%	4	2	2	3	1	0	2	0	3	1	3	4	2
90th%	4	4	4	4	4	2	-1	0	4	5	6	4	4
Spills (%):													
Average	16.7	0.0	33.3	0.0	0.0	2.9	4.1	1.8	2.3	19.4	0.0	0.0	5.3
10th%	4.8	6.7	25.0	0.0	0.0	0.9	1.9	3.4	2.4	34.9	0.0	0.0	6.2
20th%	0.0	-25.0	0.0	0.0	0.0	9.9	6.2	4.5	2.6	81.0	0.0	0.0	8.3
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hauser Operations													
Energy Production (%):													
Average	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	10.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	7.7	0.0
50th%	0.0	0.0	0.0	8.3	9.1	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0
80th%	18.2	9.1	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Holter Operations													
Energy Production (%):													
Average	3.8	0.0	3.7	0.0	4.3	0.0	3.3	0.0	0.0	8.0	5.0	4.8	3.8
10th%	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	6.7	2.8
20th%	0.0	0.0	0.0	0.0	3.4	0.0	2.5	0.0	0.0	8.8	8.0	7.7	3.0
50th%	3.7	0.0	0.0	0.0	4.5	0.0	3.2	0.0	0.0	9.1	0.0	5.3	3.8
80th%	14.3	4.8	9.1	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	5.3
90th%	0.0	6.2	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	6.2

Baseline to consumptive use alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tiber Operations													
Contents (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.2	0.2	0.2	0.1
10th%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.2	0.1	0.2	0.0
20th%	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.1
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.1	0.1	0.1	0.1	0.0
90th%	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.1	0.3	0.4	0.4	0.1
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	0	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	1	1	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
MPC's Great Falls Facilities Operations													
Black Eagle Energy Production (%):													
Average	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0
80th%	0.0	8.3	7.7	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	10.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0
Rainbow Energy Production (%):													
Average	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	4.5	4.2
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	4.8	4.8	0.0
80th%	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	4.5
90th%	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	6.2	0.0	0.0
Cochrane Energy Production (%):													
Average	3.8	0.0	4.0	0.0	4.5	0.0	0.0	0.0	0.0	3.7	9.5	4.8	3.7
10th%	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	3.3	6.9	0.0
20th%	0.0	3.4	0.0	0.0	0.0	2.6	0.0	0.0	0.0	7.5	11.1	3.8	0.0
50th%	0.0	0.0	0.0	0.0	4.8	0.0	3.1	0.0	0.0	11.5	5.6	5.3	0.0
80th%	0.0	5.0	4.8	0.0	0.0	5.3	0.0	0.0	3.6	6.2	0.0	0.0	0.0
90th%	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	7.1	0.0	0.0
Ryan Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	2.6	5.7	0.0	2.6
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0
50th%	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	11.1	6.2	6.1	2.4
80th%	2.8	2.9	5.4	3.3	3.6	3.0	0.0	0.0	0.0	6.9	3.7	0.0	2.9
90th%	6.5	0.0	3.4	0.0	4.0	0.0	0.0	0.0	2.6	7.7	8.0	0.0	3.3
Morony Energy Production (%):													
Average	3.7	0.0	3.8	0.0	4.3	0.0	3.3	0.0	0.0	3.8	9.1	4.5	3.7
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	6.7	0.0
20th%	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	10.7	3.7	3.1
50th%	0.0	0.0	0.0	0.0	4.5	0.0	2.9	0.0	0.0	11.1	5.3	5.0	3.7
80th%	0.0	4.8	4.5	5.6	5.9	5.0	0.0	0.0	3.3	5.9	6.2	5.9	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	6.7	6.2	0.0

Baseline to consumptive use alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Fort Peck Operations													
Energy Production (%):													
Average	3.5	3.2	3.4	3.7	2.7	3.3	3.6	3.3	4.2	2.6	2.9	3.2	3.5
10th%	1.8	1.7	0.0	0.7	0.0	2.1	1.2	2.1	1.7	2.1	1.6	2.5	1.7
20th%	2.9	2.7	2.1	2.4	2.7	3.4	2.5	2.2	3.6	2.2	2.5	3.6	2.7
50th%	2.4	3.3	3.3	4.1	4.5	5.6	6.2	5.7	4.9	2.6	2.9	3.2	3.7
80th%	4.5	4.1	4.2	12.8	5.9	0.0	0.0	0.0	0.0	3.1	2.4	3.9	3.4
90th%	6.7	6.2	6.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	3.9	4.3	3.8
Contents (%):													
Average	0.5	0.5	0.3	0.2	0.1	0.1	0.0	0.0	0.1	0.4	0.6	0.6	0.3
10th%	0.7	0.4	0.2	0.2	-0.1	0.0	-0.1	-0.1	0.0	0.4	0.8	0.7	0.3
20th%	0.5	0.5	0.2	0.2	0.1	-0.0	-0.1	-0.1	0.0	0.3	0.6	0.7	0.3
50th%	0.4	0.5	0.3	0.2	0.1	0.1	0.1	-0.1	0.0	0.3	0.5	0.7	0.3
80th%	0.6	0.4	0.4	0.3	0.2	0.1	0.2	0.1	0.5	0.5	0.6	0.6	0.4
90th%	0.9	0.7	0.5	0.3	0.2	0.1	0.1	0.3	0.4	0.5	1.0	1.3	0.5
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	1	0	1	0
10th%	0	1	0	0	0	0	0	0	0	1	0	1	0
20th%	0	0	0	0	0	0	0	0	0	1	0	0	0
50th%	0	0	0	1	0	0	0	0	0	1	0	1	0
80th%	1	0	0	0	0	0	0	0	0	1	1	0	1
90th%	1	1	1	0	0	0	0	0	0	0	1	1	0
Spills (%):													
Average	0.0	0.0	0.0	0.0	0.0	14.3	0.0	14.3	7.1	0.0	10.0	0.0	25.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BASELINE TO COMBINATION ALTERNATIVE (REDUCTIONS)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hebgen Operations													
Contents (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	0	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Madison Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toston Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average generation (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0
Spills (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	7.1	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	10.5	0.0	0.0	1.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	100.0	0.0	0.0	1.3
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Baseline to combination alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Canyon Ferry Operations													
Energy Production (%):													
Average	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	4.2	0.0	3.1
10th%	0.0	0.0	0.0	2.3	0.0	0.0	-2.4	0.0	0.0	0.0	2.6	2.6	0.0
20th%	0.0	0.0	0.0	0.0	-2.9	2.3	0.0	0.0	0.0	0.0	3.1	0.0	0.0
50th%	0.0	0.0	0.0	0.0	3.6	-2.7	0.0	0.0	0.0	6.5	0.0	4.8	0.0
80th%	3.6	3.7	3.6	0.0	0.0	0.0	0.0	13.6	9.5	0.0	0.0	5.0	0.0
90th%	0.0	4.8	9.1	4.8	0.0	4.8	-5.6	5.6	0.0	0.0	0.0	0.0	0.0
Contents (%):													
Average	0.9	0.9	0.7	0.7	0.6	0.6	0.4	0.3	0.4	0.7	1.1	1.1	0.8
10th%	0.4	0.2	0.2	0.0	0.2	0.0	-0.2	-0.2	0.0	0.0	0.6	0.7	0.1
20th%	-0.5	0.1	0.2	0.6	0.1	0.4	-0.1	-0.3	0.0	0.0	0.2	0.6	0.1
50th%	0.4	0.5	0.3	-0.1	0.3	-0.7	0.1	0.2	0.0	0.2	0.4	0.0	0.1
80th%	2.1	1.0	0.6	1.3	0.1	0.6	0.7	-0.1	0.4	0.8	2.0	2.4	1.0
90th%	3.4	3.4	3.5	3.5	3.7	2.0	-0.2	-0.1	2.4	1.8	3.0	3.4	2.5
Elevations (feet):													
Average	1	1	0	0	0	0	1	1	0	0	1	0	1
10th%	1	0	1	0	0	-1	0	0	0	0	0	0	0
20th%	0	0	0	1	0	0	0	0	0	0	0	1	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	1	1	0	1	0	1	1	0	0	0	1	1	1
90th%	2	2	2	1	1	1	0	0	1	1	2	1	1
Spills (%):													
Average	0.0	0.0	33.3	0.0	0.0	0.0	2.0	0.0	0.0	8.3	0.0	0.0	0.0
10th%	0.0	6.7	16.7	0.0	0.0	-2.6	0.6	2.8	0.0	13.8	0.0	0.0	1.6
20th%	-20.0	-25.0	0.0	0.0	0.0	9.9	2.7	1.5	1.3	57.1	0.0	0.0	5.6
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hauser Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	7.7	0.0
50th%	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0
80th%	9.1	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Holter Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	4.8	0.0
10th%	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.3	2.8
20th%	0.0	0.0	0.0	0.0	3.4	0.0	2.5	0.0	0.0	2.9	4.0	3.8	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	4.5	0.0	5.3	3.8
80th%	4.8	4.8	4.5	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	5.3
90th%	0.0	6.2	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0

Baseline to combination alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tiber Operations													
Contents (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.2	0.2	0.2	0.1
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
20th%	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0
90th%	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.3	0.0
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	0	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	1	1	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
MPC's Great Falls Facilities Operations													
Black Eagle Energy Production (%)													
Average	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0
80th%	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	10.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0
Rainbow Energy Production (%):													
Average	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	4.5	4.2
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0
80th%	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	4.5
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0
Cochrane Energy Production (%):													
Average	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	4.8	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0
20th%	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	2.5	7.4	3.8	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	5.3	0.0
80th%	0.0	5.0	4.8	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0
Ryan Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	3.1	3.0	0.0
80th%	2.8	0.0	2.7	0.0	0.0	3.0	0.0	0.0	0.0	3.4	3.7	0.0	0.0
90th%	3.2	0.0	3.4	0.0	0.0	0.0	0.0	0.0	2.6	3.8	4.0	0.0	0.0
Morony Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	4.5	4.5	3.7
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.3	0.0
20th%	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	3.7	5.3	5.0	0.0
80th%	0.0	4.8	0.0	0.0	0.0	5.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0

Baseline to combination alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Fort Peck Operations													
Energy Production (%):													
Average	1.2	1.1	1.7	1.2	1.4	1.6	1.8	1.6	1.4	0.9	1.0	1.1	1.2
10th%	0.9	0.8	0.0	0.7	0.8	1.0	1.2	1.0	0.8	0.7	0.0	1.7	0.8
20th%	1.0	0.9	0.7	0.8	0.9	1.1	1.3	1.1	1.8	1.5	0.8	1.8	0.9
50th%	1.2	1.1	0.8	1.4	3.0	3.7	2.1	3.8	1.6	0.9	1.0	2.1	1.3
80th%	1.5	1.4	2.1	7.7	5.9	0.0	0.0	0.0	0.0	1.0	1.2	1.3	1.7
90th%	3.3	4.6	2.4	0.0	0.0	0.0	0.0	0.0	0.0	2.3	1.3	1.4	1.9
Contents (%):													
Average	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.1
10th%	0.3	0.2	0.1	0.1	-0.0	0.0	-0.1	-0.0	0.0	0.1	0.2	0.4	0.1
20th%	0.2	0.2	0.2	0.1	0.0	0.0	-0.0	-0.0	0.0	0.1	0.3	0.3	0.1
50th%	0.2	0.2	0.2	0.1	0.0	0.0	0.1	-0.0	0.0	0.1	0.2	0.3	0.1
80th%	0.2	0.2	0.2	0.2	0.1	0.0	0.1	0.0	0.3	0.2	0.2	0.2	0.2
90th%	0.4	0.3	0.3	0.1	0.1	0.1	0.0	0.2	0.1	0.2	0.3	0.3	0.2
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	1	0	0	0
10th%	0	0	0	0	0	0	0	0	0	1	0	0	0
20th%	0	0	0	0	0	0	0	0	0	1	0	0	0
50th%	0	0	0	1	0	0	0	0	0	1	0	0	0
80th%	0	0	0	0	0	0	0	0	0	1	0	0	1
90th%	1	0	1	0	0	0	0	0	0	0	1	1	0
Spills (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BASELINE TO INSTREAM ALTERNATIVE (REDUCTIONS)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Hebgen Operations													
Contents (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	0	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Madison Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toston Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average generation (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spills (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Baseline to instream alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Canyon Ferry Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	3.1	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	4.8	0.0	0.0	0.0	0.0
90th%	4.8	4.8	4.5	4.8	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contents (%):													
Average	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.4	0.4	0.3
10th%	0.1	0.1	0.0	0.0	0.1	0.1	-0.1	-0.1	0.0	0.0	0.2	0.2	0.0
20th%	0.0	0.0	0.1	0.1	0.0	0.1	0.0	-0.1	0.0	0.0	0.1	0.2	0.1
50th%	0.2	0.1	0.1	0.1	0.1	-0.1	0.1	-0.1	0.0	0.0	0.1	0.0	0.1
80th%	0.3	0.1	0.1	0.4	0.1	0.2	0.2	0.1	0.1	0.3	0.7	0.7	0.3
90th%	0.9	0.9	1.0	1.0	1.0	0.8	-0.1	0.0	0.3	0.5	0.8	0.9	0.6
Elevations (feet):													
Average	1	0	0	0	0	0	1	0	0	0	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	1	0	1	0	0	0	0	1	0	0
90th%	0	1	0	0	0	0	0	0	0	1	1	0	1
Spills (%):													
Average	0.0	0.0	33.3	0.0	0.0	2.9	2.0	0.0	0.0	2.8	0.0	0.0	0.0
10th%	-4.8	0.0	8.3	0.0	0.0	0.0	0.0	1.1	0.0	4.6	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	2.8	0.9	0.7	0.0	14.3	0.0	0.0	2.8
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hauser Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Holter Operations													
Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8
20th%	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	3.8	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Baseline to instream alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tiber Operations													
Contents (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.1	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
20th%	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	0	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	0	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
MPC's Great Falls Facilities Operations													
Black Eagle Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0
Rainbow Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cochrane Energy Production (%):													
Average	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0
Ryan Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.4	3.7	0.0	0.0
90th%	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	3.8	0.0	0.0	0.0
Morony Energy Production (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	3.7
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0

Baseline to instream alternative reductions (continued)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Fort Peck Operations													
Energy Production (%):													
Average	0.0	0.0	0.8	1.2	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	1.2
10th%	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	-0.8	0.8	0.8
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.7	0.8	0.9	0.9
50th%	0.0	0.0	0.0	1.4	1.5	1.9	2.1	1.9	0.0	0.0	0.0	1.1	0.0
80th%	0.0	0.0	0.0	2.6	2.9	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0
90th%	1.7	1.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.9
Contents (%):													
Average	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
10th%	0.1	0.1	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0	0.1	0.1	0.0
20th%	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
50th%	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
80th%	0.1	0.1	0.1	0.1	0.0	0.0	-0.0	0.0	0.1	0.0	0.1	0.0	0.0
90th%	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Elevations (feet):													
Average	0	0	0	0	0	0	0	0	0	1	0	0	0
10th%	0	0	0	0	0	0	0	0	0	0	0	0	0
20th%	0	0	0	0	0	0	0	0	0	0	0	0	0
50th%	0	0	0	0	0	0	0	0	0	0	0	0	0
80th%	0	0	0	0	0	0	0	0	0	1	0	0	0
90th%	0	0	0	0	0	0	0	0	0	0	0	0	0
Spills (%):													
Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX D

MONTHLY FLOWS FOR STREAMS IN THE MISSOURI RIVER BASIN

Table D-1. Estimated flows (cfs) for the 50-year period from 1937 to 1986 where reservations are requested

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
GALLATIN RIVER DRAINAGE													
Baker Creek near Manhattan													
90 %	64	71	75	66	68	81	89	130	160	37	36	53	78
80 %	70	92	84	74	75	87	110	190	210	54	43	64	96
50 %	100	110	94	83	85	100	130	270	410	110	55	86	136
20 %	130	120	110	98	99	110	170	350	590	230	78	110	183
AVG	100	110	95	84	88	100	140	280	410	140	60	87	141
Big Bear Creek near Gallatin Gateway													
90 %	5	4	3	3	3	3	4	19	28	12	6	5	8
80 %	5	4	3	3	3	3	4	26	44	15	8	6	10
50 %	6	5	4	4	3	3	6	33	64	21	9	7	14
20 %	8	6	5	4	4	4	11	50	82	33	13	8	19
AVG	6	5	4	4	3	4	8	38	62	24	10	7	15
Ben Hart Creek near Belgrade													
90 %	29	29	29	28	27	27	27	29	31	30	29	29	29
80 %	29	29	29	28	28	28	29	30	32	32	30	29	29
50 %	31	30	30	29	29	29	31	35	35	34	32	31	31
20 %	32	32	32	30	32	32	33	37	38	36	34	33	33
AVG	31	31	30	30	29	30	31	34	35	34	32	31	32
Bear Canyon Creek near Bozeman													
90 %	2	1	0.7	0.6	0.5	1	5	16	10	2	0.8	1	3.4
80 %	2	2	1	1	1	2	6	20	13	4	2	2	5
50 %	3	2	2	1	2	3	11	30	23	7	3	3	8
20 %	4	4	3	2	3	5	20	43	37	13	5	4	12
AVG	3	3	2	2	2	4	13	32	26	8	4	3	8
Bridger Creek near Bozeman													
90 %	7	6	5	4	5	7	24	63	40	15	7	5	16
80 %	8	7	5	4	5	8	32	96	54	18	8	7	21
50 %	10	9	8	6	7	11	59	140	98	28	12	9	33
20 %	15	13	12	11	10	24	90	220	150	56	18	12	53
AVG	11	10	9	7	8	15	62	160	100	38	14	11	37
Cache Creek at mouth near West Yellowstone													
90 %	2	2	2	2	2	2	4	28	20	6	4	3	6
80 %	3	2	2	2	2	2	6	33	25	8	4	3	8
50 %	4	3	3	3	2	3	10	43	40	12	6	4	11
20 %	6	5	4	3	3	4	15	55	57	19	8	5	15
AVG	4	4	3	3	3	3	10	45	44	14	6	5	12
East Fork Hyalite Creek near Bozeman													
90 %	4	3	2	2	2	2	6	22	43	15	6	5	9
80 %	5	4	3	2	2	3	6	26	50	17	6	6	11
50 %	6	5	3	3	3	3	7	30	61	27	10	8	14
20 %	8	6	5	4	4	4	9	38	71	40	12	10	18
AVG	7	5	4	4	3	3	8	31	61	30	9	8	14
East Gallatin River at Bozeman													
90 %	34	38	35	31	31	43	84	140	97	41	27	35	53
80 %	42	46	41	36	37	51	98	180	110	45	29	42	63
50 %	51	51	46	40	45	56	160	260	190	67	45	52	89
20 %	62	57	52	46	51	66	220	350	270	94	60	60	116
AVG	54	51	47	41	44	60	170	270	200	74	49	52	93
East Gallatin River near Belgrade													
90 %	40	39	31	28	27	42	86	150	120	36	25	32	55
80 %	44	44	37	32	33	52	110	230	150	44	27	35	70
50 %	61	58	47	38	46	61	160	360	300	91	44	50	110
20 %	80	72	59	55	59	90	250	460	530	170	66	71	164
AVG	63	58	49	42	49	69	190	370	330	110	51	55	120
East Gallatin River near Manhattan													
90 %	170	160	140	130	140	150	180	440	430	220	160	160	207
80 %	180	170	140	140	140	160	200	570	560	290	180	170	242
50 %	210	190	160	150	160	170	240	780	830	390	220	200	308
20 %	230	210	180	160	180	210	350	1000	1200	500	280	240	395
AVG	190	180	160	150	170	180	260	780	900	410	230	200	318
Gallatin River above West Fork near Big Sky													
90 %	190	160	140	130	130	130	170	580	1000	390	250	210	290
80 %	210	170	150	140	140	150	200	740	1100	480	270	220	331
50 %	240	210	170	170	170	160	230	960	1700	710	320	280	443
20 %	320	250	210	190	190	200	340	1200	2200	1000	390	320	568
AVG	250	210	180	170	160	170	260	970	1700	760	330	280	453
Gallatin River near Gallatin Gateway													
90 %	350	300	260	250	240	250	320	1100	2000	730	460	390	554
80 %	380	330	280	270	270	270	370	1400	2100	900	510	420	625
50 %	450	380	320	310	310	310	440	1800	3200	1300	600	520	828
20 %	590	470	390	350	350	370	640	2200	4000	1900	730	610	1050
AVG	470	390	330	310	310	310	490	1800	3100	1400	620	520	838
Gallatin River near Logan													
90 %	560	610	650	580	600	700	780	1100	1300	340	330	470	668
80 %	600	780	730	650	650	740	900	1500	1700	480	390	560	807
50 %	850	890	790	710	740	860	1100	2100	3200	990	480	740	1121
20 %	1100	1000	910	830	840	950	1400	2700	4400	1800	670	920	1460
AVG	840	890	800	720	750	850	1100	2200	3200	1100	530	740	1143
Hellroaring Creek near Gallatin Gateway													
90 %	18	16	13	12	12	13	17	98	89	34	21	19	30
80 %	20	17	14	13	13	14	22	120	110	45	24	21	36
50 %	25	21	17	15	16	15	32	150	170	68	32	26	49
20 %	31	24	20	18	19	20	56	200	240	93	41	33	66
AVG	25	20	17	15	16	16	38	150	180	73	33	27	51
Hyalite Creek above interstate near Bozeman													
90 %	6	4	4	3	3	3	5	57	50	17	9	7	14
80 %	7	5	4	4	4	3	8	68	62	24	11	8	17
50 %	9	7	6	5	5	4	16	82	99	39	21	11	25
20 %	15	9	7	7	6	5	34	120	150	57	27	16	38
AVG	11	8	6	5	5	5	22	85	110	41	20	13	28
Hyalite Creek at Hyalite Reservoir near Bozeman													
90 %	24	17	13	10	12	11	19	92	150	69	35	29	40
80 %	28	19	15	13	13	14	23	100	170	91	45	34	47
50 %	36	27	21	18	17	17	35	130	210	130	84	46	64
20 %	52	34	25	21	21	23	52	170	260	170	100	60	82
AVG	39	27	21	18	17	18	39	140	220	130	78	50	66

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Middle Fork West Fork Gallatin River near Gallatin Gateway													
90 %	5	5	4	3	3	4	6	39	43	13	7	6	12
80 %	6	5	4	4	4	4	8	47	54	19	9	7	14
50 %	8	7	5	5	5	5	12	63	94	32	12	9	21
20 %	12	9	7	6	6	6	23	87	120	48	17	12	29
AVG	9	7	6	5	5	5	15	66	94	36	13	10	23
Porcupine Creek near Gallatin Gateway													
90 %	5	4	4	3	3	3	5	51	48	16	8	6	13
80 %	6	5	4	4	4	3	7	60	58	22	9	7	16
50 %	7	6	5	5	5	4	13	70	90	34	13	9	22
20 %	10	8	6	6	6	4	26	96	120	50	18	11	30
AVG	8	7	5	5	5	4	17	73	94	37	14	9	23
Reese Creek near Belgrade													
90 %	6	7	6	4	5	6	7	22	17	6	5	5	8
80 %	7	7	6	6	5	6	8	26	25	8	6	6	10
50 %	8	8	8	7	7	7	13	40	44	14	8	7	14
20 %	11	10	9	8	8	9	18	54	75	23	11	11	21
AVG	8	9	8	7	7	8	13	42	50	16	9	8	15
Rocky Creek near Bozeman													
90 %	8	9	7	7	6	10	24	52	35	9	7	9	15
80 %	10	10	9	8	9	11	28	68	47	17	10	10	20
50 %	13	13	11	10	11	15	45	100	80	29	14	13	30
20 %	20	19	16	14	14	22	72	140	120	44	21	18	43
AVG	15	14	12	11	12	17	50	110	87	31	16	15	32
Sourdough Creek near Bozeman													
90 %	10	10	8	7	7	8	11	41	42	18	12	10	15
80 %	11	11	9	8	8	8	13	45	47	21	14	12	17
50 %	15	13	11	10	10	10	19	63	73	34	20	17	25
20 %	17	15	12	12	11	12	28	93	100	44	25	19	32
AVG	15	13	11	10	10	11	23	69	76	34	20	16	26
South Cottonwood Creek near Gallatin Gateway													
90 %	15	13	11	10	10	10	13	45	76	31	19	17	22
80 %	16	14	11	11	11	11	16	57	86	38	21	18	26
50 %	19	16	13	13	12	13	19	72	120	53	25	21	33
20 %	23	20	16	15	15	16	27	89	150	75	31	25	42
AVG	20	16	14	13	13	13	20	73	120	57	26	21	34
South Fork Spanish Creek near Gallatin Gateway													
90 %	11	10	8	7	7	7	9	81	84	29	16	13	24
80 %	13	11	9	8	8	7	14	100	110	40	19	15	30
50 %	17	13	10	10	9	8	24	140	190	66	25	20	44
20 %	23	15	12	11	11	11	48	190	250	94	34	26	60
AVG	18	13	10	9	9	8	31	150	190	72	27	21	46
South Fork West Fork Gallatin River near Gallatin Gateway													
90 %	12	10	8	7	7	7	11	110	120	34	17	14	30
80 %	15	12	9	9	9	8	17	140	160	48	21	16	39
50 %	19	15	12	11	11	10	30	190	290	87	28	22	60
20 %	28	19	15	14	13	12	64	260	380	140	40	30	85
AVG	21	15	12	11	10	10	41	190	290	97	31	24	63
Spanish Creek near Gallatin Gateway													
90 %	24	21	17	15	15	16	22	120	140	54	30	26	42
80 %	28	23	18	17	17	18	30	150	190	78	36	30	53
50 %	36	29	22	20	21	20	46	230	320	120	49	40	79
20 %	47	34	27	24	25	27	85	320	410	170	67	51	107
AVG	36	28	22	20	21	21	57	240	320	130	52	41	82

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Squaw Creek near Gallatin Gateway													
90 %	14	13	12	10	11	12	16	72	61	23	15	15	23
80 %	15	14	12	11	12	13	18	86	72	29	18	16	26
50 %	19	17	14	13	13	14	25	100	110	43	23	19	34
20 %	23	20	17	15	16	17	43	130	170	62	28	23	47
AVG	19	17	14	13	14	15	30	100	120	46	24	20	36
Taylor Creek near Grayling													
90 %	22	17	17	16	14	14	19	120	290	98	42	30	58
80 %	25	20	18	17	16	14	22	160	330	130	49	32	69
50 %	29	25	20	19	19	16	32	210	440	190	65	40	92
20 %	37	34	22	21	24	18	45	280	500	280	89	49	117
AVG	31	26	20	19	20	17	34	230	420	200	68	42	94
Thompson Creek near Belgrade													
90 %	27	27	24	24	21	20	21	26	27	30	28	27	25
80 %	30	28	26	27	25	23	27	30	32	31	30	29	28
50 %	33	33	30	31	30	30	32	40	38	35	32	32	33
20 %	36	35	32	34	35	34	41	44	41	37	35	35	37
AVG	33	32	29	30	29	29	33	37	37	35	32	32	32
West Fork Gallatin River near Gallatin Gateway													
90 %	24	20	17	15	15	14	21	180	200	61	32	27	52
80 %	29	23	18	17	17	16	31	220	260	88	39	31	66
50 %	37	29	23	21	21	19	54	320	450	150	52	42	102
20 %	52	36	28	25	25	24	110	430	600	220	72	55	140
AVG	39	29	24	21	21	20	70	320	460	170	56	44	106
West Fork Hyalite Creek near Bozeman													
90 %	9	7	5	5	5	5	9	38	80	25	11	10	17
80 %	10	8	6	6	6	5	9	44	88	33	13	12	20
50 %	12	10	8	7	7	7	12	55	100	55	17	15	25
20 %	16	12	10	9	9	8	15	69	110	84	23	17	32
AVG	13	10	9	8	7	7	13	56	100	62	18	14	26
MADISON RIVER DRAINAGE													
Antelope Creek at mouth near Cameron													
90 %	4	3	3	2	3	3	7	26	20	7	15	14	9
80 %	5	4	3	3	3	4	9	32	27	10	16	15	10
50 %	6	5	4	4	4	5	14	48	48	16	19	16	16
20 %	9	7	6	5	5	7	22	66	70	24	22	19	22
AVG	7	6	5	4	4	6	16	50	52	18	19	17	17
Beaver Creek near West Yellowstone													
90 %	21	18	17	15	14	14	20	160	160	60	30	25	46
80 %	24	20	18	17	16	15	26	190	200	84	36	28	56
50 %	29	25	21	19	19	17	45	230	290	120	51	35	75
20 %	37	31	23	22	24	18	82	310	390	170	70	44	102
AVG	31	26	21	19	20	17	55	240	300	130	54	37	79
Blaine Spring Creek near Cameron													
90 %	24	22	21	21	21	21	23	31	36	30	25	23	25
80 %	24	23	21	22	21	22	23	34	41	33	26	25	26
50 %	27	24	23	23	22	23	25	38	47	39	29	26	29
20 %	30	26	25	24	24	24	29	43	51	43	35	28	32
AVG	27	25	23	23	23	23	26	38	45	38	30	26	29
Cabin Creek near West Yellowstone													
90 %	7	5	5	4	4	3	5	120	140	31	12	8	29
80 %	8	6	6	5	5	3	10	140	180	47	16	11	36
50 %	10	7	7	7	6	4	23	180	300	88	21	13	56
20 %	16	11	9	8	7	3	54	250	370	150	32	18	77
AVG	13	9	8	7	6	4	33	180	300	100	23	15	58

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Cherry Creek near Norris													
90 %	20	17	13	9	14	14	21	72	75	34	20	19	27
80 %	22	19	14	12	15	15	25	93	110	46	23	22	35
50 %	27	22	17	15	17	18	38	140	160	67	35	28	49
20 %	31	25	20	18	20	24	61	200	220	94	48	36	66
AVG	26	22	17	15	18	20	43	150	170	77	36	29	52
Cougar Creek near West Yellowstone													
90 %	7	6	6	6	5	5	10	130	120	27	12	9	29
80 %	9	8	7	7	7	6	14	150	140	36	15	11	34
50 %	11	10	9	10	9	8	28	160	210	63	21	14	46
20 %	20	18	14	12	10	9	63	220	320	120	29	18	71
AVG	16	14	11	10	8	9	41	170	230	73	22	15	52
Duck Creek near West Yellowstone													
90 %	22	20	18	16	17	18	22	90	72	34	23	22	31
80 %	24	21	19	18	18	19	26	110	91	43	27	24	37
50 %	28	25	21	19	20	20	35	140	140	58	33	29	47
20 %	32	26	22	21	23	24	59	190	210	75	41	35	63
AVG	27	23	20	19	21	20	41	140	150	61	35	30	49
Elk River at mouth near Cameron													
90 %	11	10	10	8	8	10	21	140	110	31	19	14	33
80 %	14	12	12	10	10	11	27	160	140	44	21	16	40
50 %	19	18	15	13	13	14	44	210	210	66	29	20	56
20 %	29	25	20	17	16	18	68	270	300	100	38	25	77
AVG	22	19	17	14	13	15	49	220	230	73	30	21	60
Grayling Creek near West Yellowstone													
90 %	16	13	12	10	9	8	13	190	210	63	26	19	49
80 %	19	15	13	12	12	9	21	230	280	94	33	23	63
50 %	23	18	16	15	14	11	44	290	430	160	46	30	91
20 %	34	25	19	18	17	11	96	400	540	230	69	40	125
AVG	28	21	17	15	14	11	61	300	430	170	50	33	96
Hot Springs Creek near Norris													
90 %	5	4	4	3	3	3	6	23	20	10	6	6	8
80 %	6	5	4	4	4	4	7	30	26	13	8	7	10
50 %	7	6	5	5	5	5	11	39	42	19	13	8	14
20 %	10	8	6	6	6	6	20	55	63	25	15	11	19
AVG	8	7	5	5	5	6	14	41	45	20	12	9	15
Indian Creek near Cameron													
90 %	19	16	15	14	13	13	19	170	170	61	29	24	47
80 %	23	19	17	16	15	13	25	200	220	87	36	27	58
50 %	28	24	19	18	18	15	45	250	320	130	50	34	79
20 %	37	31	23	21	22	17	87	330	430	190	70	43	108
AVG	31	25	20	18	19	16	58	260	330	140	53	36	84
Jack Creek near Ennis													
90 %	19	14	14	11	11	11	14	55	92	40	23	21	27
80 %	21	15	15	12	12	11	17	70	110	54	26	22	32
50 %	23	18	16	14	13	14	23	93	150	71	33	27	41
20 %	25	19	17	16	14	15	35	130	190	87	41	32	52
AVG	23	18	16	14	13	13	25	98	150	71	34	27	42
Madison River below Ennis Lake near McAllister													
90 %	1100	1100	1200	1100	1000	980	900	1100	1500	1200	1200	1200	1132
80 %	1400	1400	1300	1200	1200	1200	1000	1300	1800	1400	1400	1300	1325
50 %	2000	2100	1500	1500	1400	1400	1500	1900	2900	1700	1600	1700	1767
20 %	2400	2500	1700	1600	1600	1700	2100	2500	3900	2400	1800	2000	2183
AVG	1900	2000	1500	1400	1400	1400	1600	1900	3000	1900	1600	1700	1775

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Madison River below Hebgen Lake near Grayling													
90 %	480	690	700	690	570	390	260	230	220	660	800	690	532
80 %	880	830	770	760	680	550	400	310	590	780	910	890	696
50 %	1400	1400	890	910	790	800	800	590	1200	1000	1100	1200	1007
20 %	1800	1900	1100	1100	950	1100	1400	1200	1800	1300	1200	1400	1354
AVG	1300	1400	970	890	820	810	920	730	1200	1000	1100	1200	1028
Madison River near Cameron													
90 %	970	880	920	890	780	710	510	790	1300	1100	1000	1000	904
80 %	1100	1000	1000	950	880	810	750	1000	1600	1300	1200	1200	1066
50 %	1700	1600	1100	1100	1000	1000	1200	1500	2500	1600	1300	1400	1417
20 %	2100	2100	1300	1200	1200	1300	1700	2000	3500	2000	1500	1600	1792
AVG	1600	1600	1200	1100	1000	1100	1200	1600	2600	1600	1300	1400	1442
Madison River near Three Forks													
90 %	1100	1300	1500	1100	1100	990	940	1100	1600	1100	1000	1200	1169
80 %	1400	1400	1500	1200	1200	1200	1100	1300	1800	1300	1200	1300	1325
50 %	2000	1900	1800	1500	1400	1400	1500	2000	3000	1700	1500	1600	1775
20 %	2500	2300	1900	1600	1600	1800	2100	2500	4100	2500	1700	1800	2200
AVG	2000	1900	1700	1400	1400	1500	1600	2000	3100	1900	1500	1600	1800
Madison River near West Yellowstone													
90 %	340	340	340	330	340	340	410	640	530	360	330	340	387
80 %	380	390	370	360	370	380	430	680	630	420	370	380	430
50 %	440	430	430	420	410	410	460	800	850	520	440	420	502
20 %	500	470	460	450	440	430	540	990	1000	670	510	490	579
AVG	440	420	420	410	410	410	480	830	850	530	440	430	506
Moore Creek at Ennis													
90 %	0.6	0.5	0.5	0.5	0.4	0.4	1	8	6	2	1	0.8	1.8
80 %	0.7	0.7	0.6	0.6	0.6	0.5	1	10	7	2	1	1	2.1
50 %	0.9	0.8	0.8	0.8	0.7	0.9	3	12	13	4	2	1	3.3
20 %	2	2	1	1	0.8	0.9	6	17	21	7	2	2	5.2
AVG	1	1	1	0.8	0.7	1	4	12	14	4	2	1	3.5
North Fork Meadow Creek at Forest Service boundary near Ennis													
90 %	6	4	3	3	3	2	5	47	54	21	10	8	14
80 %	8	5	4	4	3	3	8	58	71	34	13	10	18
50 %	11	8	6	5	5	4	16	83	110	56	31	15	29
20 %	17	10	7	6	6	6	30	120	140	70	43	21	40
AVG	12	8	6	5	5	4	19	88	110	58	29	16	30
North Fork Meadow Creek at Highway near Ennis													
90 %	4	3	2	2	2	2	3	34	33	11	6	4	9
80 %	4	3	3	2	2	2	5	41	42	17	8	6	11
50 %	6	4	4	3	3	3	10	52	67	28	15	8	17
20 %	10	6	5	4	4	3	21	75	97	41	20	11	25
AVG	7	5	4	3	3	3	14	54	71	30	14	9	18
O'Dell Creek near Ennis													
90 %	110	100	99	95	94	94	99	130	150	120	110	110	109
80 %	110	100	100	97	95	95	100	140	150	130	110	110	111
50 %	110	100	100	100	98	99	110	150	160	140	120	110	116
20 %	110	110	100	100	99	100	120	160	170	140	120	120	121
AVG	110	100	100	99	98	98	110	150	160	140	120	110	116
Red Canyon Creek near West Yellowstone													
90 %	0.3	0.2	0.3	0.4	0.2	0.3	1	21	16	2	0.9	0.5	4
80 %	0.4	0.4	0.5	0.4	0.4	0.4	2	19	18	3	1	0.6	4
50 %	0.5	0.6	0.7	0.8	0.6	0.8	3	23	30	6	2	0.8	5
20 %	2	2	2	1	0.7	0.7	8	28	43	14	2	1	9
AVG	1	1	1	1	0.6	1	5	21	31	8	2	1	6

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Ruby Creek near Cameron													
90 %	3	3	3	2	2	2	4	18	17	7	4	3	6
80 %	3	3	3	2	2	3	4	22	20	9	5	4	7
50 %	4	4	3	3	3	3	7	26	32	13	6	4	9
20 %	5	5	4	4	4	4	12	36	47	19	8	6	13
AVG	4	4	3	3	3	3	9	27	34	14	6	5	10
Soap Creek at mouth near Cameron													
90 %	0.6	0.5	0.6	0.4	0.5	0.5	2	8	6	2	1	1	2
80 %	0.8	0.7	0.6	0.5	0.5	0.6	2	10	7	2	2	1	2
50 %	1	1	0.8	0.8	0.7	1	3	14	12	4	2	1	3
20 %	2	2	1	1	1	1	5	18	18	6	3	2	5
AVG	2	1	1	0.8	0.8	1	4	14	13	4	2	2	4
South Fork Madison River near West Yellowstone													
90 %	98	91	85	83	82	84	94	170	220	140	110	100	113
80 %	100	95	88	87	87	87	100	190	230	150	120	110	120
50 %	110	100	94	93	93	92	110	210	280	190	130	120	135
20 %	130	110	100	98	98	100	130	240	320	220	140	130	151
AVG	110	100	95	93	92	93	110	220	280	190	130	120	136
Squaw Creek near Cameron													
90 %	6	5	5	4	4	5	7	47	39	13	8	7	12
80 %	6	6	5	5	5	5	8	54	45	17	9	7	14
50 %	8	7	6	6	6	6	13	57	68	25	12	9	19
20 %	10	9	7	7	7	6	22	76	99	38	16	11	26
AVG	8	7	6	6	6	6	15	59	73	28	13	9	20
Standard Creek near Cameron													
90 %	5	4	4	3	3	3	5	25	31	14	7	6	9
80 %	5	5	4	4	4	3	6	32	40	20	9	6	12
50 %	7	6	5	4	4	4	10	46	60	29	12	8	16
20 %	8	7	5	5	5	5	17	62	75	37	17	10	21
AVG	7	6	5	4	5	4	12	48	61	31	13	9	17
Trapper Creek near West Yellowstone													
90 %	1	1	1	1	1	1	2	19	14	4	2	2	4
80 %	2	1	1	1	1	1	2	21	16	5	3	2	5
50 %	2	2	2	2	1	1	4	22	26	8	4	3	6
20 %	3	3	2	2	2	2	8	29	38	13	5	3	9
AVG	3	2	2	2	2	1	6	22	28	9	4	3	7
Watkins Creek near West Yellowstone													
90 %	2	1	1	1	1	1	2	33	28	6	3	2	7
80 %	2	2	2	1	1	1	3	36	32	9	4	2	8
50 %	2	2	2	2	2	2	6	37	51	15	5	3	11
20 %	4	4	3	3	2	2	13	50	70	27	7	4	16
AVG	3	3	2	2	2	2	9	38	53	18	5	3	12
West Fork Madison River near Cameron													
90 %	42	37	31	30	28	32	45	160	150	70	44	43	59
80 %	44	41	35	31	31	34	53	180	180	100	55	46	69
50 %	51	45	40	36	38	42	79	250	270	140	67	57	93
20 %	59	56	49	44	45	53	110	330	380	180	84	64	121
AVG	54	48	42	38	39	45	84	250	280	140	69	56	95
JEFFERSON RIVER DRAINAGE													
Boulder River above Cabin Gulch near Boulder													
90 %	23	30	26	22	25	35	62	230	140	31	16	17	55
80 %	30	33	30	28	30	39	79	260	190	52	20	22	68
50 %	42	41	35	36	38	47	120	380	340	83	30	32	102
20 %	63	50	43	40	47	65	200	490	530	170	50	47	150
AVG	46	43	36	34	39	54	140	390	360	110	36	36	110

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Boulder River above High Ore Creek near Basin													
90 %	14	19	16	13	15	23	46	220	120	20	9	10	44
80 %	19	22	19	17	19	26	62	260	180	38	12	13	57
50 %	29	28	23	24	26	34	110	410	360	66	20	20	96
20 %	47	36	30	28	33	48	190	550	600	150	35	33	148
AVG	32	30	24	23	26	39	130	420	380	94	24	24	104
Boulder River near Cardwell													
90 %	29	37	32	27	30	43	76	280	170	38	20	21	67
80 %	36	41	37	34	37	48	98	320	240	64	25	27	84
50 %	52	51	43	44	47	58	150	470	420	100	38	39	126
20 %	77	62	53	50	58	79	240	600	650	210	61	58	183
AVG	57	53	45	42	48	67	180	480	450	140	45	44	138
Boulder River near Boulder													
90 %	18	25	21	17	19	30	59	280	160	26	12	12	57
80 %	24	28	24	22	25	34	79	330	230	48	15	17	73
50 %	37	36	30	30	33	43	140	520	460	84	25	26	122
20 %	60	46	38	35	42	62	240	700	770	190	45	42	189
AVG	41	38	31	29	33	50	160	530	490	120	31	30	132
Hells Canyon Creek near Twin Bridges													
90 %	2	2	2	2	1	2	3	13	13	5	3	2	4
80 %	2	2	2	2	2	2	3	17	16	7	3	3	5
50 %	3	3	2	2	2	2	5	21	26	10	5	3	7
20 %	4	4	3	3	3	3	10	30	37	15	6	4	10
AVG	3	3	2	2	2	3	7	22	27	11	5	4	8
Jefferson River at Sappington													
90 %	870	1300	1100	910	960	1100	1500	2200	2000	600	250	560	1112
80 %	1000	1500	1200	960	1000	1300	1800	2700	3300	930	410	710	1401
50 %	1500	1600	1300	1100	1200	1400	2300	4000	5800	2100	690	1100	2008
20 %	1900	1900	1600	1400	1400	1600	3300	5700	8700	3400	1200	1800	2825
AVG	1500	1700	1400	1200	1300	1400	2600	4400	6000	2400	790	1200	2158
Jefferson River near Three Forks													
90 %	1100	1400	970	1000	880	1300	1500	1800	2600	630	450	790	1202
80 %	1300	1500	1100	1100	1100	1400	2100	2300	3600	1000	540	890	1494
50 %	1800	1900	1400	1300	1400	1700	2700	4300	6200	1900	850	1300	2229
20 %	2200	2200	1800	1500	1700	1900	3300	6200	10000	3200	1400	1800	3100
AVG	1800	1900	1400	1300	1400	1600	2700	4400	6900	2300	1000	1300	2333
Jefferson River near Twin Bridges													
90 %	770	1100	970	840	880	910	1300	2000	2000	550	310	580	1018
80 %	900	1200	1000	890	970	1000	1600	2400	3100	910	520	710	1267
50 %	1300	1500	1300	1000	1100	1200	2100	3700	5400	2000	770	1000	1864
20 %	1700	1800	1500	1200	1300	1500	3000	5300	7800	3100	1100	1300	2550
AVG	1300	1500	1300	1100	1100	1200	2300	4000	5500	2100	840	1000	1937
Little Boulder River near Boulder													
90 %	8	7	6	5	5	7	9	51	25	8	4	5	12
80 %	10	7	6	5	6	8	11	55	37	13	5	6	14
50 %	12	9	8	8	8	10	17	68	59	19	8	9	20
20 %	15	12	10	9	10	15	27	85	91	27	12	16	27
AVG	12	10	8	8	8	11	20	71	66	20	10	11	21
North Willow Creek at Pony													
90 %	2	6	7	6	7	10	11	31	23	5	3	3	10
80 %	5	8	9	7	7	11	13	38	31	8	4	3	12
50 %	12	15	11	8	9	12	18	44	53	23	6	6	18
20 %	18	17	13	11	12	16	23	63	80	36	10	13	26
AVG	11	13	11	9	11	13	18	46	59	25	7	8	19

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Norwegian Creek near Harrison													
90 %	5	5	5	3	4	5	8	7	6	3	3	5	5
80 %	6	6	5	3	4	6	8	9	7	4	4	5	6
50 %	7	6	5	4	5	7	10	12	10	6	7	7	7
20 %	8	7	6	5	5	7	12	14	13	10	9	10	9
AVG	7	6	5	4	5	7	10	12	10	7	8	7	7
South Boulder River near Jefferson Island													
90 %	13	11	8	8	7	4	6	33	110	49	25	15	24
80 %	14	12	9	9	8	9	10	36	120	55	28	17	27
50 %	18	14	11	11	11	10	15	41	150	71	32	23	34
20 %	25	19	15	14	14	14	25	49	170	86	37	29	41
AVG	19	15	12	11	11	11	17	44	150	71	32	23	35
South Willow Creek near Pony													
90 %	3	7	8	6	7	12	14	61	42	10	5	4	15
80 %	6	9	11	9	9	13	19	74	60	12	7	5	20
50 %	17	22	16	11	12	16	30	90	110	46	8	8	32
20 %	33	27	19	15	17	23	45	140	180	80	14	21	51
AVG	17	19	15	12	14	17	31	94	130	50	10	12	35
Whitetail Creek near Whitehall													
90 %	3	2	2	1	1	1	3	8	22	19	20	10	8
80 %	4	2	2	1	1	1	3	13	24	22	22	13	9
50 %	7	2	2	1	2	2	4	23	39	25	28	17	13
20 %	10	3	2	2	3	3	5	37	51	28	33	21	16
AVG	7	3	2	1	2	2	4	25	39	25	27	18	13
Willow Creek near Harrison													
90 %	4	16	18	15	17	25	25	21	30	7	3	4	15
80 %	11	19	23	20	20	26	30	33	55	13	4	5	22
50 %	30	37	30	24	25	30	41	58	96	58	8	13	38
20 %	52	44	35	29	31	36	54	99	150	96	18	34	56
AVG	31	34	29	24	27	31	42	63	110	62	11	20	40
BIG HOLE RIVER DRAINAGE													
Adson Creek at mouth near Wise River													
90 %	1	1	1	0.7	0.8	0.9	2	11	8	3	2	1	2.7
80 %	1	1	1	0.9	1	1	3	14	10	4	2	2	3.4
50 %	2	2	1	1	1	2	5	20	18	6	3	2	5
20 %	3	2	2	2	2	2	8	27	27	9	4	3	8
AVG	2	2	2	1	1	2	6	21	20	6	3	3	6
American Creek at mouth near Wise River													
90 %	0.5	0.4	0.4	0.3	0.4	0.4	1	4	3	1	0.8	0.6	1.1
80 %	0.7	0.6	0.5	0.4	0.4	0.5	2	6	4	2	1	0.8	1.6
50 %	1	0.8	0.6	0.6	0.6	0.8	3	9	8	3	2	1	2.5
20 %	2	1	0.8	0.8	0.8	1	4	12	12	4	2	2	3.5
AVG	1	0.9	0.7	0.6	0.6	0.9	3	9	9	3	2	1	2.6
Andrus Creek near mouth near Jackson													
90 %	3	3	2	2	2	2	5	20	16	6	4	3	6
80 %	4	3	3	2	2	3	7	25	21	8	4	4	7
50 %	5	4	3	3	3	4	12	38	37	12	7	5	11
20 %	7	6	4	4	4	6	18	53	55	19	10	7	16
AVG	6	5	4	3	3	4	13	40	40	14	7	6	12
Bear Creek near Wise River													
90 %	1	0.9	0.8	0.6	0.6	0.6	0.8	9	6	3	2	1	2.2
80 %	1	1	0.9	0.7	0.7	0.6	1	12	10	4	2	2	3.0
50 %	2	1	1	1	0.9	0.7	3	17	17	6	3	2	4.5
20 %	2	1	1	1	1	1	7	23	24	7	4	3	6
AVG	2	1	1	0.9	0.9	0.8	4	17	18	6	3	2	4.7

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Big Hole River below Mudd Creek near Wisdom													
90 %	120	140	110	90	110	130	280	890	770	180	93	93	250
80 %	150	160	120	110	120	140	450	1100	1300	320	140	100	351
50 %	210	210	160	140	140	170	620	1700	2200	650	200	140	545
20 %	310	280	200	180	190	230	1000	2700	3500	1000	300	240	844
AVG	230	220	170	140	150	190	720	1900	2300	710	220	170	593
Big Hole River below North Fork near Wisdom													
90 %	110	130	100	85	100	120	260	820	710	170	86	83	231
80 %	130	150	120	98	110	130	410	1000	1200	290	130	93	322
50 %	190	190	150	130	130	160	570	1500	1900	590	190	130	486
20 %	280	260	180	160	180	210	920	2400	3100	920	280	200	758
AVG	210	200	150	130	140	180	670	1700	2100	650	210	160	542
Big Hole River near Jackson													
90 %	12	9	8	7	7	8	13	85	140	24	14	13	28
80 %	13	10	9	8	8	9	15	96	160	40	17	14	33
50 %	17	13	11	10	10	11	22	130	200	78	22	17	45
20 %	22	18	14	12	13	15	43	170	240	110	29	23	59
AVG	18	14	12	10	11	12	29	140	200	85	23	18	48
Big Hole River near Melrose													
90 %	310	350	280	230	280	320	660	1900	1600	440	240	240	571
80 %	360	400	310	270	290	350	1000	2300	2700	730	340	260	776
50 %	490	490	390	350	340	420	1300	3300	4200	1400	490	340	1126
20 %	710	650	470	430	450	550	2100	5000	6400	2100	700	560	1677
AVG	530	520	400	350	370	470	1500	3600	4400	1500	520	410	1214
Big Hole River near Wise River													
90 %	160	200	160	130	160	180	400	1200	1100	260	130	130	351
80 %	200	230	180	150	170	200	630	1500	1800	450	190	140	487
50 %	280	290	220	200	200	240	870	2300	2900	900	290	190	740
20 %	430	390	280	250	270	320	1400	3600	4700	1400	420	300	1147
AVG	320	300	230	200	210	280	1000	2600	3200	990	310	240	823
Big Lake Creek near mouth near Wisdom													
90 %	3	3	3	2	2	3	6	26	20	7	5	4	7
80 %	4	4	3	3	3	3	8	32	27	9	5	4	9
50 %	6	5	4	4	4	4	13	47	46	15	8	6	14
20 %	8	7	5	5	5	6	20	64	68	23	11	8	19
AVG	6	5	4	4	4	5	15	50	50	17	8	7	15
Birch Creek near Glen													
90 %	11	7	6	6	5	5	8	26	69	37	13	8	17
80 %	12	8	6	6	6	6	9	33	79	46	18	10	20
50 %	15	10	8	8	7	7	11	45	100	63	28	12	26
20 %	20	13	10	10	8	9	17	69	140	81	37	16	36
AVG	16	11	8	8	7	7	12	51	110	66	28	13	28
Bryant Creek at mouth near Wise River													
90 %	2	1	1	1	1	1	3	13	10	4	2	2	3
80 %	2	2	2	1	1	2	4	16	13	5	3	2	4
50 %	3	3	2	2	2	2	7	24	23	8	4	3	7
20 %	4	3	3	2	3	3	11	33	34	11	6	4	10
AVG	3	3	2	2	2	3	8	25	25	8	5	4	8
California Creek above American Creek near Wise River													
90 %	2	2	2	1	1	2	4	11	9	4	2	2	4
80 %	3	2	2	2	2	2	5	15	12	5	3	3	5
50 %	4	3	2	2	2	3	8	23	23	8	5	4	7
20 %	5	4	3	3	3	4	12	33	34	12	7	5	10
AVG	4	3	2	2	2	3	9	25	25	9	5	4	8

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Camp Creek at Melrose													
90 %	1	0.9	0.7	0.7	0.5	1	2	13	12	3	2	1	3.1
80 %	2	1	1	0.8	1	2	3	17	19	4	3	2	4.7
50 %	3	2	1	1	2	2	7	24	49	15	4	3	9
20 %	5	4	2	2	2	5	13	51	97	32	7	5	19
AVG	3	3	2	1	1	3	8	29	54	18	4	3	11
Canyon Creek near Divide													
90 %	3	3	2	2	2	2	5	46	38	8	4	3	10
80 %	4	3	3	3	3	3	6	54	51	12	6	4	13
50 %	5	4	4	4	4	4	12	65	88	24	8	5	19
20 %	9	8	6	5	4	5	27	96	130	41	10	7	29
AVG	7	6	5	4	4	5	18	69	93	26	8	6	21
Corral Creek at mouth near Wise River													
90 %	0.5	0.4	0.4	0.3	0.4	0.4	1	5	4	1	1	0.7	1.3
80 %	0.7	0.6	0.5	0.4	0.5	0.5	2	7	5	2	1	0.8	1.8
50 %	1	0.9	0.7	0.6	0.6	0.8	3	10	9	3	2	1	2.7
20 %	2	1	1	0.8	0.9	1	4	14	13	4	2	2	2.8
AVG	1	1	0.7	0.6	0.7	0.9	3	10	10	3	2	1	2.8
Deep Creek near Wise River													
90 %	22	21	15	15	14	14	25	100	84	43	25	20	33
80 %	25	23	17	17	15	15	40	130	130	53	29	24	43
50 %	31	27	22	19	18	17	66	250	210	73	36	30	67
20 %	35	27	23	21	27	26	99	330	300	89	47	39	89
AVG	30	25	21	18	20	19	71	260	230	74	39	32	70
Divide Creek at Divide													
90 %	2	2	2	2	1	2	4	24	21	6	3	3	6
80 %	3	3	2	2	2	2	5	31	29	8	4	3	8
50 %	3	3	3	3	3	4	9	40	52	15	5	4	12
20 %	6	6	5	4	3	4	20	60	78	26	7	5	19
AVG	5	5	4	3	3	4	13	43	55	17	6	4	14
Fishtrap Creek at mouth near Wise River													
90 %	5	5	4	4	3	3	8	95	70	16	8	6	19
80 %	7	6	5	5	4	4	14	110	99	19	10	7	24
50 %	8	7	7	7	6	6	30	190	170	34	12	9	40
20 %	15	12	10	8	8	7	60	270	270	64	16	13	63
AVG	12	9	8	7	6	6	39	200	190	38	13	10	45
Fox Creek at mouth near Jackson													
90 %	2	2	1	1	1	1	3	15	11	4	3	2	4
80 %	2	2	2	1	1	2	5	18	14	5	3	2	5
50 %	3	3	2	2	2	2	8	26	25	8	5	3	7
20 %	5	4	3	3	3	3	11	36	37	12	6	5	11
AVG	4	3	2	2	2	3	8	28	27	9	5	4	8
Francis Creek at mouth near Wisdom													
90 %	3	3	2	2	2	2	4	21	16	6	4	3	6
80 %	4	3	2	2	2	2	6	29	24	7	4	3	7
50 %	4	4	3	3	3	3	12	48	42	12	6	5	12
20 %	6	5	4	4	4	4	20	66	63	18	8	6	17
AVG	5	4	3	3	3	3	14	50	45	12	6	5	13
French Creek near mouth near Wise River													
90 %	4	4	3	2	3	3	7	20	16	6	4	4	6
80 %	5	4	3	3	3	4	9	26	22	8	5	5	8
50 %	7	6	4	4	4	5	14	41	41	14	8	7	13
20 %	9	7	5	5	6	8	22	59	62	22	12	9	19
AVG	7	6	5	4	4	6	16	44	45	16	9	7	14

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Gold Creek at mouth near Wise River													
90 %	1	1	1	0.9	1	1	3	15	11	4	2	2	4
80 %	2	1	1	1	1	1	4	18	13	5	3	2	4
50 %	2	2	2	2	1	2	6	25	23	7	4	3	7
20 %	4	3	2	2	2	2	9	32	33	11	5	4	9
AVG	3	2	2	2	2	2	7	26	25	8	4	3	7
Governor Creek near Jackson													
90 %	14	13	10	10	9	9	18	74	63	27	16	12	23
80 %	16	15	11	11	10	10	28	95	95	33	19	15	30
50 %	19	18	15	13	12	13	46	170	160	49	23	19	46
20 %	25	20	17	15	18	18	72	230	230	69	30	25	64
AVG	21	18	15	13	13	15	51	180	170	51	25	20	49
Jacobson Creek at mouth near Wise River													
90 %	8	7	7	6	6	7	15	95	74	22	13	10	22
80 %	10	9	8	7	7	8	20	110	92	30	15	12	27
50 %	14	13	11	10	9	10	32	150	150	46	21	14	40
20 %	21	18	14	12	12	14	50	190	210	71	28	19	55
AVG	16	13	12	10	10	11	36	150	160	51	22	16	42
Jerry Creek near Wise River													
90 %	6	5	4	4	4	4	5	37	31	13	8	6	11
80 %	7	6	5	4	4	4	8	49	46	18	10	8	14
50 %	9	7	6	5	5	5	15	72	76	29	13	10	21
20 %	11	8	7	6	7	7	29	99	110	36	17	12	29
AVG	10	7	6	5	5	6	19	74	80	30	14	10	22
Johnson Creek at mouth near Wise River													
90 %	1	0.8	0.7	0.6	0.7	0.8	2	7	5	2	1	1	1.9
80 %	1	1	0.9	0.8	0.8	1	3	9	7	3	2	1	2.5
50 %	2	2	1	1	1	1	5	14	13	4	3	2	4
20 %	3	2	2	1	2	2	7	20	19	7	4	3	6
AVG	2	2	1	1	1	2	5	15	14	5	3	2	4
Johnson Creek near Wisdom													
90 %	3	3	2	3	2	2	6	38	31	8	4	3	9
80 %	4	4	3	3	3	3	10	45	43	10	5	4	11
50 %	5	5	4	4	3	4	17	74	75	17	7	5	18
20 %	8	7	6	5	5	6	29	110	110	30	9	7	28
AVG	7	6	5	4	4	5	20	79	80	19	7	6	20
Joseph Creek at mouth near Wisdom													
90 %	2	2	2	2	2	2	5	28	21	7	4	3	7
80 %	3	3	2	2	2	2	7	33	26	9	5	4	8
50 %	4	4	3	3	3	3	11	45	43	13	7	5	12
20 %	7	5	4	4	4	4	16	59	61	20	9	6	17
AVG	5	4	3	3	3	3	12	47	47	15	7	5	13
Lacy Creek at mouth near Wise River													
90 %	3	2	2	2	2	2	6	28	21	7	4	3	7
80 %	4	3	3	2	2	3	7	33	26	9	5	4	8
50 %	5	4	4	3	3	4	12	47	45	14	8	5	13
20 %	7	6	5	4	4	5	18	62	65	22	10	7	18
AVG	6	5	4	3	3	4	13	49	49	16	8	6	14
Lamarche Creek near Wise River													
90 %	11	9	8	7	6	7	10	99	87	26	13	11	24
80 %	12	10	9	8	8	8	15	120	130	37	18	13	32
50 %	16	13	11	10	10	10	29	160	210	67	24	17	48
20 %	22	18	14	12	12	13	58	230	290	94	32	23	68
AVG	18	14	12	10	10	11	38	170	210	71	25	19	51

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Meadow Creek near Wise River													
90 %	2	2	1	1	1	1	4	15	11	4	3	2	4
80 %	2	2	2	1	2	2	5	19	15	5	3	3	5
50 %	3	3	2	2	2	2	8	27	26	8	5	3	8
20 %	5	4	3	3	3	3	12	37	38	13	7	5	11
AVG	4	3	2	2	2	3	8	29	28	9	5	4	8
Miner Creek near Jackson													
90 %	6	7	6	5	5	5	15	43	100	28	13	6	20
80 %	7	8	6	5	6	6	18	50	110	36	14	7	23
50 %	11	10	8	7	7	8	23	75	140	57	17	9	31
20 %	16	13	10	9	9	10	29	110	160	93	22	13	41
AVG	12	11	8	7	7	8	24	82	140	70	19	10	33
Mono Creek at mouth near Wise River													
90 %	0.9	0.8	0.8	0.6	0.7	0.7	2	10	7	3	2	1	2.5
80 %	1	1	0.9	0.7	0.8	1	3	12	9	3	2	1	3.0
50 %	2	2	1	1	1	1	5	17	16	5	3	2	5
20 %	3	2	2	1	2	2	7	23	23	7	4	3	7
AVG	2	2	1	1	1	1	5	18	17	6	3	2	5
Moose Creek near Divide													
90 %	5	5	3	3	3	4	7	17	15	8	5	4	7
80 %	5	5	4	4	3	4	9	22	22	9	6	5	8
50 %	6	6	5	4	4	5	13	37	37	13	7	6	12
20 %	7	7	6	5	6	7	18	51	52	18	9	7	16
AVG	6	6	5	4	5	5	14	39	39	14	7	6	12
Mussigbrod Creek near Wisdom													
90 %	2	2	2	2	1	1	3	38	28	8	4	3	8
80 %	3	2	2	2	2	1	6	47	53	9	5	4	11
50 %	4	3	3	3	2	2	15	160	120	16	6	5	28
20 %	6	4	3	3	3	2	32	260	190	27	8	6	45
AVG	5	4	3	3	2	2	19	170	120	17	7	5	30
North Fork Big Hole River near mouth near Wisdom													
90 %	29	28	19	20	17	18	40	190	180	66	34	25	56
80 %	34	31	23	23	20	20	69	250	300	83	41	32	77
50 %	43	39	32	28	26	28	120	570	520	130	52	41	136
20 %	58	48	40	33	41	40	200	810	740	190	71	56	194
AVG	47	41	33	28	28	32	140	610	550	140	55	44	146
Oregon Creek near mouth near Wise River													
90 %	0.2	0.2	0.1	0.1	0.1	0.1	0.5	2	2	0.6	0.4	0.3	0.6
80 %	0.3	0.2	0.2	0.1	0.2	0.2	0.7	3	2	0.7	0.5	0.3	0.7
50 %	0.4	0.3	0.2	0.2	0.2	0.3	1	4	4	1	0.8	0.5	1.1
20 %	0.7	0.5	0.3	0.3	0.3	0.5	2	6	5	2	1	0.7	1.6
AVG	0.5	0.4	0.3	0.2	0.3	0.4	1	5	4	1	0.8	0.6	1.2
Pattengail Creek at mouth near Wise River													
90 %	11	11	9	8	8	10	20	88	73	23	14	12	24
80 %	14	13	11	10	10	12	26	110	95	32	17	14	30
50 %	19	17	14	13	13	15	41	150	160	52	25	19	45
20 %	27	22	18	16	16	20	64	210	230	82	35	26	64
AVG	21	18	15	13	13	16	46	160	170	59	26	21	48
Pintlar Creek near Forest Service boundary near Wisdom													
90 %	5	4	3	3	3	2	6	60	53	15	7	5	14
80 %	6	5	4	4	3	3	13	73	100	18	9	6	20
50 %	7	6	5	5	4	4	31	280	220	32	11	8	51
20 %	12	8	7	6	6	5	58	460	330	49	15	11	81
AVG	9	7	6	5	4	4	36	310	230	34	12	9	56

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Ruby Creek at mouth near Wisdom													
90 %	4	4	3	3	3	3	7	40	34	11	6	4	10
80 %	5	5	4	4	3	3	12	50	50	13	7	5	13
50 %	7	6	5	5	4	5	21	90	88	21	9	7	22
20 %	10	9	7	6	7	7	35	130	130	35	12	9	33
AVG	8	7	6	5	5	6	24	97	94	23	9	7	24
Sevenmile Creek at mouth near Wise River													
90 %	0.4	0.3	0.3	0.3	0.3	0.3	1	5	3	1	0.8	0.6	1.1
80 %	0.6	0.5	0.4	0.3	0.4	0.4	1	6	4	2	1	0.7	1.4
50 %	0.9	0.7	0.5	0.5	0.5	0.6	2	8	8	2	2	1	2.2
20 %	1	1	0.7	0.7	0.7	1	4	11	11	4	2	1	3.2
AVG	1	0.8	0.6	0.5	0.5	0.7	3	9	8	3	2	1	2.5.
Seymour Creek near Wise River													
90 %	6	5	5	4	4	5	11	58	45	14	9	7	14
80 %	7	7	6	5	5	6	15	69	57	19	10	8	18
50 %	10	9	8	7	7	8	24	95	95	30	15	11	27
20 %	15	12	10	9	9	10	36	130	140	47	20	14	38
AVG	12	10	8	7	7	9	26	99	100	34	15	12	28
Sheep Creek at mouth near Wise River													
90 %	2	1	2	1	1	1	4	19	13	5	3	2	4
80 %	2	2	2	1	1	2	5	22	17	6	3	3	6
50 %	3	3	2	2	2	2	8	31	29	9	5	3	8
20 %	5	4	3	3	3	3	12	41	42	14	7	5	12
AVG	4	3	2	2	2	3	8	32	32	10	5	4	9
Sixmile Creek at mouth near Wise River													
90 %	0.3	0.3	0.3	0.2	0.2	0.3	0.8	4	3	1	0.6	0.5	1.0
80 %	0.5	0.4	0.3	0.3	0.3	0.3	1	5	3	1	0.7	0.6	1.1
50 %	0.7	0.6	0.4	0.4	0.4	0.5	2	7	6	2	1	0.8	1.8
20 %	1	0.8	0.6	0.5	0.6	0.8	3	9	9	3	2	1	2.6
AVG	0.8	0.6	0.5	0.4	0.4	0.6	2	7	7	2	1	1	1.9
Steel Creek above Francis Creek near Wisdom													
90 %	2	2	1	1	1	1	3	11	10	4	3	2	3
80 %	2	2	2	2	1	1	5	14	17	5	3	2	5
50 %	3	3	2	2	2	2	8	32	29	8	4	3	8
20 %	4	3	3	2	3	3	13	45	40	11	5	4	11
AVG	3	3	2	2	2	2	9	35	31	9	4	3	9
Steel Creek near mouth near Wisdom													
90 %	5	5	4	4	3	3	7	34	28	11	7	5	10
80 %	6	6	4	4	4	4	12	44	43	14	8	6	13
50 %	8	7	6	5	5	5	20	78	73	21	10	8	20
20 %	11	8	7	6	7	7	34	110	110	31	13	10	30
AVG	9	7	6	5	5	6	24	82	78	22	10	8	22
Sullivan Creek at mouth near Wise River													
90 %	2	1	1	1	1	1	3	19	14	5	3	2	4
80 %	2	2	2	1	1	2	5	23	17	6	3	2	6
50 %	3	3	2	2	2	2	7	31	29	9	5	3	8
20 %	5	3	3	3	2	3	11	40	41	13	6	4	11
AVG	3	3	2	2	2	2	8	32	31	10	5	4	9
Swamp Creek near mouth near Wisdom													
90 %	6	6	4	4	4	3	7	52	41	16	9	6	13
80 %	7	6	5	5	4	4	14	68	70	20	11	8	18
50 %	9	8	6	6	5	5	28	150	130	30	13	10	33
20 %	13	9	8	7	8	7	50	210	180	43	17	14	47
AVG	11	8	7	6	5	5	33	160	130	32	14	11	35

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tenmile Creek at mouth near Wise River													
90 %	2	2	2	1	1	2	4	24	18	6	4	3	6
80 %	2	2	2	2	2	2	5	29	22	7	4	3	7
50 %	4	3	3	2	2	3	9	39	36	11	6	4	10
20 %	5	4	3	3	3	3	13	50	52	17	8	5	14
AVG	4	3	3	2	2	3	10	40	39	12	6	4	11
Tie Creek at Forest Service boundary near Wisdom													
90 %	5	5	5	4	4	5	10	51	40	13	8	6	13
80 %	7	6	5	5	5	5	13	61	51	17	9	7	16
50 %	9	8	7	6	6	7	21	86	85	27	14	10	24
20 %	14	11	9	8	8	10	33	110	120	42	18	13	33
AVG	10	9	8	6	6	8	24	89	93	30	14	11	26
Trail Creek near Wisdom													
90 %	15	15	9	11	9	9	20	230	87	36	19	13	39
80 %	17	16	11	12	9	10	35	270	170	40	21	16	52
50 %	21	19	16	14	12	13	63	370	270	57	24	20	75
20 %	26	22	19	15	21	20	110	480	410	73	32	25	104
AVG	22	19	16	14	14	15	73	380	280	58	26	20	78
Trapper Creek near Melrose													
90 %	4	4	3	3	3	3	5	30	24	8	5	4	8
80 %	4	4	4	3	3	4	6	35	30	10	6	5	10
50 %	6	5	4	4	4	5	10	41	50	17	8	6	13
20 %	8	7	6	5	5	6	18	58	73	25	10	7	19
AVG	6	6	5	4	4	5	13	43	53	18	8	6	14
Twelvemile Creek at mouth near Wise River													
90 %	1	1	1	1	1	1	3	16	12	4	3	2	4
80 %	2	2	1	1	1	2	4	20	15	5	3	2	5
50 %	3	2	2	2	2	2	7	28	26	8	5	3	8
20 %	4	3	3	2	2	3	10	36	37	12	6	4	10
AVG	3	3	2	2	2	2	7	29	28	9	5	3	8
Warm Springs Creek at Jackson													
90 %	8	8	6	6	5	6	13	50	46	16	9	7	15
80 %	9	9	7	7	6	7	19	62	66	19	10	8	19
50 %	11	11	9	8	8	10	31	110	110	30	14	11	30
20 %	16	15	13	10	12	13	47	150	160	50	18	14	43
AVG	13	12	10	9	9	11	34	110	120	33	14	11	32
Willow Creek near Glen													
90 %	7	6	5	5	5	5	7	23	36	16	10	8	11
80 %	8	7	6	6	6	6	8	26	46	19	14	10	14
50 %	10	8	7	7	6	7	10	37	63	28	17	12	18
20 %	12	10	8	8	8	8	15	48	81	39	21	15	23
AVG	10	8	7	7	7	7	11	37	64	30	17	12	18
Wise River near Wise River													
90 %	35	35	35	31	31	30	45	260	330	93	56	44	85
80 %	41	40	37	34	32	34	56	300	580	140	72	50	118
50 %	54	48	44	37	36	40	75	500	830	240	89	63	171
20 %	85	57	50	43	40	45	110	780	1200	350	120	86	247
AVG	61	49	44	38	36	40	83	530	860	260	93	69	180
Wyman Creek at mouth near Wise River													
90 %	4	4	4	3	3	4	8	39	30	10	6	5	10
80 %	6	5	4	4	4	5	11	47	39	14	8	6	13
50 %	8	7	6	5	5	6	18	67	67	22	11	8	19
20 %	11	9	7	7	7	8	28	91	97	33	15	11	27
AVG	9	7	6	5	5	7	20	70	73	24	12	9	21

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
RUBY RIVER DRAINAGE													
Coal Creek at mouth near Alder													
90 %	2	1	1	1	1	1	3	13	10	4	2	2	3
80 %	2	2	2	1	1	2	4	17	13	5	3	2	4
50 %	3	3	2	2	2	2	7	25	24	8	4	3	7
20 %	4	3	3	2	3	3	11	34	34	12	6	4	10
AVG	3	3	2	2	2	3	8	26	26	9	5	4	8
Cottonwood Creek at mouth near Alder													
90 %	3	3	3	2	2	2	6	27	20	7	4	4	7
80 %	4	3	3	2	3	3	8	32	26	9	5	4	8
50 %	5	5	4	3	3	4	12	46	45	15	8	6	13
20 %	8	6	5	4	4	6	19	63	66	22	11	8	18
AVG	6	5	4	3	4	4	14	49	49	16	8	6	14
East Fork Ruby River at mouth near Alder													
90 %	2	2	2	2	2	2	4	20	15	5	3	3	5
80 %	3	2	2	2	2	2	6	24	19	7	4	3	6
50 %	4	3	3	3	2	3	9	34	33	11	6	4	10
20 %	6	4	4	3	3	4	14	46	48	16	8	6	14
AVG	4	4	3	2	3	3	10	36	36	12	6	5	10
Mill Creek at Forest Service boundary near Sheridan													
90 %	7	6	6	5	5	5	7	54	62	25	12	9	17
80 %	9	7	6	6	5	5	9	66	80	36	14	10	21
50 %	11	9	7	7	6	5	17	90	120	53	21	13	30
20 %	14	11	8	7	8	6	31	120	150	70	29	17	39
AVG	11	9	7	6	7	5	21	94	120	58	22	14	31
North Fork Greenhorn Creek at mouth near Alder													
90 %	1	1	1	1	1	1	3	11	9	3	2	2	3
80 %	2	2	2	1	1	1	4	14	12	4	3	2	0
50 %	3	2	2	2	2	2	6	19	21	7	4	3	6
20 %	4	3	2	2	2	3	9	27	30	10	5	4	8
AVG	3	2	2	2	2	2	7	21	22	8	4	3	6
Ruby River above reservoir near Alder													
90 %	91	100	93	76	84	89	110	260	240	98	76	84	117
80 %	100	110	97	90	90	94	120	300	280	110	97	91	132
50 %	120	120	110	100	100	110	160	410	440	180	120	110	173
20 %	140	140	130	120	110	120	220	530	650	260	150	140	226
AVG	120	120	110	100	100	110	170	430	480	200	120	110	181
Ruby River above the forks near Alder													
90 %	6	6	5	4	5	5	11	40	33	12	7	6	12
80 %	8	7	6	5	5	6	14	50	44	16	9	8	15
50 %	11	9	7	7	7	8	23	75	77	26	14	10	23
20 %	14	12	9	8	9	12	35	100	110	40	19	15	32
AVG	11	10	8	7	7	9	25	79	83	29	14	12	24
Ruby River near Twin Bridges													
90 %	140	160	140	120	110	110	92	63	84	89	66	140	110
80 %	170	190	150	120	120	120	100	120	170	120	100	150	136
50 %	230	220	160	140	130	150	190	250	340	240	140	190	198
20 %	260	250	200	170	150	210	290	360	550	350	190	280	272
AVG	220	220	180	150	130	170	200	250	380	240	140	210	208
Warm Springs Creek at mouth near Alder													
90 %	46	46	45	44	44	45	51	81	74	52	47	46	52
80 %	48	47	46	45	45	46	54	91	85	56	49	48	55
50 %	50	49	47	47	47	48	63	117	118	66	54	50	63
20 %	54	52	49	48	49	51	75	150	160	80	59	54	73
AVG	51	49	48	47	47	49	65	121	125	69	54	51	65

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
West Fork Ruby River at mouth near Alder													
90 %	3	2	2	2	2	2	5	22	17	6	4	3	6
80 %	3	3	3	2	2	3	7	28	22	8	5	4	8
50 %	5	4	3	3	3	4	11	40	39	13	7	5	11
20 %	7	5	4	4	4	5	17	55	57	19	9	7	16
AVG	5	4	4	3	3	4	12	42	42	14	7	6	12
Wisconsin Creek at Forest Service boundary near Sheridan													
90 %	5	4	4	3	3	3	5	52	51	17	8	6	13
80 %	6	5	4	4	4	3	7	62	63	24	10	7	17
50 %	7	6	5	5	5	4	13	74	96	38	14	9	23
20 %	10	8	6	6	6	4	26	100	130	54	20	12	32
AVG	8	7	5	5	5	4	17	77	99	41	15	10	24
RED ROCK RIVER AND BEAVERHEAD RIVER DRAINAGES													
Antelope Creek near Lakeview													
90 %	0.1	0.1	0.1	0.1	0.1	0.2	0.3	2	1	0.3	0.2	0.2	0.4
80 %	0.2	0.2	0.1	0.1	0.1	0.2	0.3	2	1	0.3	0.2	0.2	0.4
50 %	0.2	0.2	0.2	0.2	0.2	0.2	0.5	2	3	0.6	0.3	0.2	0.6
20 %	0.4	0.3	0.3	0.2	0.2	0.2	1	3	4	1	0.4	0.3	0.9
AVG	0.3	0.3	0.2	0.2	0.2	0.2	0.7	2	3	0.7	0.3	0.2	0.7
Bear Creek near Grant													
90 %	3	3	2	2	2	2	4	12	11	5	3	3	4
80 %	3	3	2	2	2	2	6	16	17	7	4	3	6
50 %	4	4	3	3	2	3	9	31	29	9	5	4	9
20 %	5	4	3	3	4	4	14	43	40	12	6	5	12
AVG	4	4	3	3	3	3	10	33	31	10	5	4	9
Beaverhead River at Barretts													
90 %	200	190	180	180	180	200	220	200	350	290	230	180	217
80 %	230	250	230	230	230	270	270	300	480	340	290	240	280
50 %	360	410	350	300	310	330	370	580	840	580	440	360	436
20 %	480	520	420	350	360	420	590	830	1100	870	740	510	599
AVG	380	390	350	300	300	340	420	570	830	630	530	410	454
Beaverhead River near Dillon													
90 %	140	280	280	210	260	280	210	36	27	28	49	130	161
80 %	180	340	330	270	300	320	270	98	110	80	65	150	209
50 %	330	490	470	380	380	410	380	180	230	160	150	330	324
20 %	520	610	560	440	470	520	650	460	610	330	260	450	490
AVG	380	500	460	370	380	420	430	270	370	240	210	360	366
Beaverhead River near Twin Bridges													
90 %	220	380	340	270	340	360	290	62	49	49	80	190	219
80 %	260	440	410	340	380	400	360	140	160	120	100	220	278
50 %	440	600	510	430	450	500	490	240	300	230	200	410	400
20 %	640	710	610	510	520	590	710	560	680	400	330	570	569
AVG	480	590	520	440	450	500	520	340	430	300	260	440	439
Big Sheep Creek below Muddy Creek near Dell													
90 %	39	45	38	34	32	36	49	31	45	41	34	32	38
80 %	46	47	40	37	35	39	62	40	51	47	51	40	45
50 %	59	54	47	40	39	46	79	63	91	64	63	51	58
20 %	72	62	52	47	46	53	100	99	140	80	81	64	75
AVG	59	55	46	42	41	48	86	72	94	67	65	52	61
Black Canyon Creek near Grant													
90 %	2	2	1	1	1	1	3	9	6	3	2	2	3
80 %	2	2	1	1	1	2	4	11	8	3	2	2	3
50 %	2	2	2	1	2	2	5	15	15	6	3	2	5
20 %	3	3	2	2	2	3	8	22	22	8	4	3	7
AVG	3	2	2	1	2	2	6	16	16	6	3	3	5

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Blacktail Deer Creek near Dillon													
90 %	35	30	26	23	20	31	39	45	70	40	30	32	35
80 %	38	35	27	25	27	36	42	63	85	48	40	37	42
50 %	44	42	32	30	34	41	54	78	120	77	46	43	53
20 %	49	50	38	33	40	53	67	120	160	100	58	52	68
AVG	44	44	32	30	34	44	55	88	120	81	48	44	55
Bloody Dick Creek near Grant													
90 %	11	11	8	8	7	8	17	72	62	23	13	10	21
80 %	13	13	9	9	8	9	25	90	92	29	16	13	27
50 %	17	15	13	11	10	12	42	160	150	44	20	16	42
20 %	22	19	16	13	16	17	65	210	220	66	26	21	59
AVG	18	16	13	12	12	13	47	160	160	47	21	17	45
Browns Canyon Creek near Grant													
90 %	1	0.9	0.8	0.7	0.7	0.8	2	10	7	3	2	1	2.5
80 %	1	1	1	0.8	0.9	1	3	13	10	3	2	2	3.2
50 %	2	2	1	1	1	1	5	18	17	5	3	2	5
20 %	3	2	2	2	2	2	7	25	24	8	4	3	7
AVG	2	2	1	1	1	2	5	19	18	6	3	2	5
Cabin Creek above Simpson Creek near Lima													
90 %	0.2	0.2	0.2	0.2	0.2	0.2	0.5	2	2	0.7	0.6	0.3	0.6
80 %	0.3	0.3	0.3	0.2	0.2	0.2	0.7	3	2	1	0.6	0.4	0.8
50 %	0.5	0.4	0.4	0.3	0.3	0.4	1	3	4	2	1	0.6	1.2
20 %	0.8	0.6	0.5	0.4	0.4	0.6	2	5	6	2	1	0.9	1.7
AVG	0.6	0.5	0.4	0.3	0.3	0.4	1	4	5	2	1	0.7	1.4
Corral Creek at mouth near Alder													
90 %	0.4	0.4	0.4	0.3	0.3	0.4	1	5	3	1	0.8	0.6	1.1
80 %	0.6	0.5	0.4	0.4	0.4	0.4	2	6	4	2	1	0.7	1.5
50 %	1	0.7	0.6	0.5	0.5	0.7	3	8	8	2	2	1	2.3
20 %	1	1	0.8	0.7	0.7	1	4	12	11	4	2	2	3.4
AVG	1	0.8	0.6	0.5	0.6	0.8	3	9	8	3	2	1	2.5
Corral Creek near Lakeview													
90 %	0.7	0.6	0.6	0.5	0.5	0.5	0.6	4	4	2	1	1	1.3
80 %	0.8	0.7	0.6	0.5	0.5	0.5	0.9	5	5	3	1	1	1.6
50 %	1	0.9	0.7	0.6	0.6	0.5	2	7	8	4	2	1	2.4
20 %	1	1	0.7	0.7	0.8	0.6	3	10	10	4	3	2	3.1
AVG	1	0.8	0.7	0.6	0.7	0.5	2	8	8	4	2	1	2.4
Deadman Creek near Dell													
90 %	3	3	3	2	2	3	5	15	10	4	3	2	5
80 %	4	4	3	3	2	3	7	19	12	5	4	3	6
50 %	5	5	4	3	3	4	9	21	24	8	6	4	8
20 %	7	6	5	4	4	5	14	31	39	13	9	6	12
AVG	5	5	4	3	3	5	10	22	26	9	6	5	9
East Fork Blacktail Creek near Dillon													
90 %	15	16	12	11	11	12	19	48	42	25	16	14	20
80 %	17	16	13	13	11	13	26	64	63	30	18	16	25
50 %	21	19	16	13	13	14	37	110	97	40	23	20	35
20 %	22	19	16	15	19	20	50	140	140	47	29	24	45
AVG	19	17	15	13	15	15	38	110	100	40	24	20	36
East Fork Clover Creek at mouth near Monida													
90 %	0.7	0.6	0.6	0.5	0.5	0.6	2	6	5	2	1	0.9	1.7
80 %	1	0.8	0.7	0.6	0.6	0.7	2	8	6	2	1	1	2.0
50 %	1	1	0.9	0.8	0.8	1	4	12	11	4	2	2	3.4
20 %	2	2	1	1	1	2	5	17	16	5	3	2	5
AVG	2	1	1	0.8	0.9	1	4	13	12	4	2	2	3.6

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
East Fork Dyce Creek at mouth near Polaris													
90 %	0.5	0.5	0.5	0.4	0.4	0.5	1	5	5	2	1	0.8	1.5
80 %	0.8	0.7	0.6	0.5	0.5	0.6	1	6	6	2	1	1	1.7
50 %	1	1	0.8	0.7	0.6	0.8	2	8	10	3	2	1	2.6
20 %	2	1	1	1	0.9	1	4	11	13	5	3	2	3.7
AVG	1	1	1	0.7	0.7	1	3	9	10	4	2	1	2.9
Frying Pan Creek near Grant													
90 %	1	1	1	0.8	0.8	1	3	6	4	2	2	1	2
80 %	2	2	1	1	1	1	3	8	7	3	2	1	3
50 %	2	2	1	1	1	2	5	13	11	5	3	2	4
20 %	3	2	2	1	2	3	7	19	17	6	3	3	6
AVG	2	2	1	1	1	2	5	14	13	5	3	2	4
Grasshopper Creek near Dillon													
90 %	24	29	18	19	19	27	54	42	37	12	12	11	25
80 %	27	34	21	20	21	32	62	57	52	18	16	12	31
50 %	34	39	30	23	27	44	71	100	120	42	26	17	48
20 %	46	45	38	32	33	73	91	160	200	69	38	28	71
AVG	36	39	30	25	27	53	74	110	140	48	28	20	52
Hellroaring Creek near Lakeview													
90 %	6	5	5	4	4	4	5	41	39	18	10	8	12
80 %	7	6	5	5	4	4	7	52	51	24	11	9	15
50 %	9	7	6	5	5	4	13	70	77	34	16	11	21
20 %	11	8	6	6	7	5	25	93	100	43	21	14	28
AVG	9	7	6	5	5	4	16	71	80	37	16	12	22
Horse Prairie Creek near Grant													
90 %	29	33	21	21	21	29	64	100	83	42	30	26	42
80 %	34	37	23	24	25	31	70	130	130	58	34	28	52
50 %	44	44	31	28	30	39	100	210	220	100	44	36	77
20 %	57	54	40	33	41	63	160	340	330	140	55	50	114
AVG	45	45	33	29	32	47	110	250	240	100	45	39	85
Indian Creek above Simpson Creek near Lima													
90 %	0.3	0.3	0.3	0.3	0.3	0.3	0.7	4	3	1	0.9	0.5	1.0
80 %	0.5	0.4	0.4	0.3	0.3	0.3	1	4	4	2	1	0.6	1.2
50 %	0.7	0.6	0.5	0.5	0.4	0.5	2	5	7	2	2	0.8	1.8
20 %	1	1	0.7	0.6	0.5	0.7	2	7	9	3	2	1	2.4
AVG	0.8	0.7	0.6	0.5	0.4	0.6	2	6	7	2	1	1	1.9
Jones Creek near Lakeview													
90 %	0.5	0.4	0.5	0.4	0.4	0.4	1	5	4	2	1	0.7	1.4
80 %	0.7	0.6	0.5	0.4	0.5	0.5	2	7	5	2	1	1	1.8
50 %	1	0.9	0.7	0.7	0.6	0.8	3	9	10	3	2	1	2.7
20 %	2	1	1	0.9	0.9	1	4	13	14	5	3	2	4.0
AVG	1	1	0.8	0.7	0.7	0.9	3	10	10	3	2	1	2.8
Long Creek near Lakeview													
90 %	2	2	2	2	2	2	3	17	15	7	4	3	5
80 %	3	2	2	2	2	2	4	23	19	9	5	3	6
50 %	3	3	3	2	2	2	7	29	32	12	6	4	9
20 %	5	4	3	3	3	2	13	40	46	18	8	5	12
AVG	4	3	3	2	2	2	9	30	34	13	6	5	9
Medicine Lodge Creek near Grant													
90 %	5	4	3	3	2	5	9	39	33	8	5	4	10
80 %	6	6	4	4	4	6	11	49	41	10	6	6	13
50 %	8	8	6	6	6	9	18	55	75	24	9	7	19
20 %	12	13	9	8	8	13	33	85	120	47	13	11	31
AVG	10	10	7	6	6	11	23	59	83	28	10	8	22

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Narrows Creek at mouth near Lakeview													
90 %	0.1	0.1	0.1	0.1	0.1	0.1	0.4	2	1	0.4	0.3	0.2	0.4
80 %	0.2	0.2	0.1	0.1	0.1	0.1	0.6	2	1	0.5	0.3	0.2	0.5
50 %	0.3	0.2	0.2	0.2	0.2	0.2	1	3	3	0.8	0.6	0.4	0.8
20 %	0.5	0.3	0.2	0.2	0.2	0.3	1	5	4	1	0.8	0.5	1.2
AVG	0.4	0.3	0.2	0.2	0.2	0.2	1	3	3	1	0.6	0.4	0.9
Odell Creek near Lakeview													
90 %	5	4	4	4	3	3	5	35	30	13	8	6	10
80 %	6	5	4	4	4	4	6	44	39	18	9	7	12
50 %	7	6	5	5	5	4	12	56	60	25	12	8	17
20 %	9	7	5	5	6	4	22	75	85	33	16	11	23
AVG	8	6	5	5	5	4	15	57	64	27	13	9	18
Painter Creek near Grant													
90 %	2	1	1	1	1	1	3	16	12	4	3	2	4
80 %	2	2	2	1	1	2	5	20	15	5	3	2	5
50 %	3	3	2	2	2	2	7	28	26	8	5	3	8
20 %	4	3	3	2	2	3	11	37	38	13	6	4	10
AVG	3	3	2	2	2	2	8	29	29	9	5	4	8
Peet Creek at county road near Lakeview													
90 %	0.5	0.5	0.4	0.4	0.4	0.5	1	5	4	2	1	0.7	1.4
80 %	0.7	0.6	0.5	0.4	0.5	0.6	2	7	5	2	1	1	1.8
50 %	1	0.9	0.6	0.6	0.7	0.8	3	11	10	3	2	1	2.9
20 %	2	1	0.9	1	1	1	5	15	14	4	2	2	4.1
AVG	1	1	0.7	0.7	0.7	1	3	11	10	3	2	1	2.9
Pole Creek near mouth near Polaris													
90 %	0.6	0.5	0.5	0.4	0.4	0.5	1	7	5	2	1	0.8	1.6
80 %	0.8	0.7	0.6	0.5	0.5	0.6	2	9	6	2	1	1	2.1
50 %	1	1	0.8	0.7	0.7	0.9	3	12	11	3	2	1	3.1
20 %	2	1	1	1	1	1	5	16	16	5	3	2	4
AVG	1	1	0.9	0.7	0.8	1	4	13	12	4	2	2	3.5
Rape Creek above reservoir near Grant													
90 %	0.2	0.2	0.2	0.1	0.1	0.2	0.4	2	1	0.5	0.4	0.3	0.5
80 %	0.3	0.3	0.2	0.2	0.2	0.2	0.6	2	2	0.7	0.5	0.3	0.6
50 %	0.5	0.4	0.3	0.3	0.2	0.3	1	3	3	1	0.8	0.5	0.9
20 %	0.7	0.5	0.4	0.3	0.3	0.5	2	4	5	2	1	0.8	1.5
AVG	0.5	0.4	0.3	0.2	0.3	0.4	1	3	3	1	0.8	0.6	1.0
Red Rock Creek near Lakeview													
90 %	11	10	9	8	8	8	10	58	48	24	14	12	18
80 %	12	11	9	9	9	8	13	75	63	30	17	14	22
50 %	14	12	10	10	10	9	21	97	95	41	22	16	30
20 %	17	14	11	11	12	10	39	130	140	52	28	20	40
AVG	15	12	10	9	10	9	26	98	100	43	23	18	31
Red Rock River at Red Rock													
90 %	180	190	180	130	140	120	170	78	90	150	100	170	142
80 %	210	220	190	150	140	140	190	100	120	180	120	190	162
50 %	290	260	210	170	160	170	270	250	190	240	150	230	216
20 %	360	300	240	180	180	200	370	470	420	290	240	290	295
AVG	300	270	230	180	170	190	280	310	250	250	180	250	238
Red Rock River below Lima Reservoir near Monida													
90 %	11	5	10	11	8	7	16	180	280	250	110	33	77
80 %	17	12	16	17	14	13	21	220	380	270	160	52	99
50 %	45	23	23	23	22	21	40	290	460	330	260	140	140
20 %	84	58	33	28	31	28	73	450	590	410	310	250	195
AVG	57	40	26	23	22	21	55	330	470	340	240	150	148

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Red Rock River near Kennedy Ranch near Lakeview													
90 %	38	41	12	13	16	26	190	170	120	40	20	20	59
80 %	49	48	17	25	31	42	220	240	170	57	27	32	80
50 %	66	70	29	33	47	56	350	360	270	110	46	47	124
20 %	88	84	42	60	63	98	520	490	350	170	76	69	176
AVG	67	67	31	39	49	67	350	380	280	120	53	49	129
Reservoir Creek at mouth near Polaris													
90 %	0.9	0.7	0.6	0.5	0.6	0.7	2	5	4	2	1	1	1.6
80 %	1	1	0.7	0.6	0.7	0.8	2	7	5	2	1	1	1.9
50 %	2	1	1	1	1	1	4	11	10	4	2	2	3
20 %	2	2	1	1	1	2	6	16	15	5	3	3	5
AVG	2	1	1	1	1	2	4	12	11	4	2	2	4
Shenon Creek near mouth near Grant													
90 %	0.4	0.4	0.3	0.3	0.3	0.3	0.9	3	2	1	0.7	0.5	0.8
80 %	0.6	0.5	0.4	0.3	0.4	0.4	1	4	3	1	0.8	0.6	1.1
50 %	0.8	0.7	0.5	0.5	0.5	0.6	2	6	6	2	1	1	1.8
20 %	1	1	0.7	0.6	0.7	1	3	9	9	3	2	1	2.7
AVG	1	0.7	0.6	0.5	0.5	0.7	2	6	7	2	1	1	1.9
Simpson Creek above Indian Creek near Lima													
90 %	0.4	0.3	0.4	0.3	0.3	0.3	0.8	4	3	1	1	0.6	1.0
80 %	0.5	0.5	0.4	0.3	0.3	0.4	1	5	4	2	1	0.7	1.3
50 %	0.8	0.7	0.6	0.5	0.4	0.6	2	6	7	2	2	1	2.0
20 %	1	1	0.8	0.6	0.6	0.8	3	8	10	4	2	1	2.7
AVG	1	0.8	0.7	0.5	0.5	0.6	2	6	8	3	2	1	2.2
Tom Creek near Lakeview													
90 %	0.4	0.3	0.3	0.3	0.2	0.2	0.5	9	7	2	1	0.6	1.8
80 %	0.5	0.4	0.4	0.3	0.3	0.3	1	11	9	3	1	0.7	2.3
50 %	0.7	0.5	0.5	0.5	0.4	0.4	2	11	14	4	2	1	3.1
20 %	1	1	0.7	0.7	0.5	0.4	5	16	21	7	2	1	4.7
AVG	1	0.8	0.6	0.5	0.4	0.4	3	12	15	5	2	1	3.5
Trapper Creek at mouth near Grant													
90 %	0.3	0.3	0.3	0.2	0.2	0.3	0.7	3	2	0.9	0.6	0.4	0.8
80 %	0.4	0.4	0.3	0.3	0.3	0.3	1	4	3	1	0.7	0.5	1.0
50 %	0.7	0.6	0.4	0.4	0.4	0.5	2	5	5	2	1	0.7	1.6
20 %	1	0.7	0.6	0.5	0.5	0.8	3	7	8	3	2	1	2.3
AVG	0.8	0.6	0.5	0.4	0.4	0.6	2	6	6	2	1	0.9	1.8
West Fork Blacktail Creek near Dillon													
90 %	5	7	5	4	4	5	9	17	13	6	5	4	7
80 %	7	7	6	5	5	6	11	23	17	8	7	6	9
50 %	10	9	7	6	6	8	15	28	32	13	11	8	13
20 %	12	11	8	7	8	10	20	42	51	19	16	11	18
AVG	9	9	7	6	6	9	16	30	35	14	11	8	13
West Fork Dyce Creek at mouth near Polaris													
90 %	0.3	0.2	0.3	0.2	0.2	0.2	0.6	3	3	1	0.7	0.5	0.8
80 %	0.4	0.4	0.3	0.3	0.3	0.3	0.8	4	3	1	0.8	0.5	1.0
50 %	0.6	0.6	0.4	0.4	0.3	0.5	1	5	6	2	1	0.7	1.5
20 %	1	0.8	0.6	0.5	0.5	0.7	2	7	8	3	2	1	2.3
AVG	0.8	0.6	0.5	0.4	0.4	0.5	2	5	6	2	1	0.8	1.7

MISSOURI RIVER DRAINAGE - THREE FORKS TO HOLTER DAM

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Avalanche Gulch near Winston													
90 %	0.7	0.8	0.8	1	0.7	1	3	19	14	2	1	0.8	3.7
80 %	1	1	1	1	1	2	3	20	15	2	1	1	4
50 %	1	2	2	2	2	2	6	23	28	5	2	1	6
20 %	3	4	3	2	2	3	11	30	46	15	3	2	10
AVG	3	3	2	2	2	3	8	22	31	7	2	2	7
Beaver Creek at mouth near East Helena													
90 %	5	6	5	5	5	6	9	18	15	7	4	4	7
80 %	6	6	6	5	6	7	11	20	17	9	4	5	8
50 %	8	7	7	6	7	8	15	25	23	11	7	6	11
20 %	11	11	9	8	9	10	20	29	31	18	11	12	15
AVG	8	8	8	7	8	9	16	28	27	13	8	8	12
Beaver Creek near Winston													
90 %	2	2	1	1	1	1	4	27	23	6	2	2	6
80 %	3	3	2	2	1	2	7	32	43	10	4	2	9
50 %	5	5	4	3	3	4	16	51	68	19	6	4	16
20 %	8	7	5	4	4	6	30	80	110	30	8	6	25
AVG	6	5	4	3	3	4	18	55	74	21	6	4	17
Confederate Gulch near Winston													
90 %	5	4	3	3	4	4	5	30	24	10	6	5	9
80 %	6	5	4	3	4	4	7	38	33	12	7	6	11
50 %	7	6	5	4	4	4	12	50	51	18	10	8	15
20 %	9	7	5	5	5	6	21	68	76	28	13	10	21
AVG	7	6	5	4	5	5	14	52	56	21	10	8	16
Cottonwood Creek above Beartooth Ranch near Wolf Creek													
90 %	0.5	0.4	0.4	0.4	0.3	0.3	0.8	9	6	1	1	0.6	1.7
80 %	0.6	0.6	0.5	0.4	0.4	0.4	1	11	7	2	1	0.8	2.1
50 %	0.9	1	0.7	0.7	0.6	0.7	3	15	14	3	2	1	3.5
20 %	2	2	1	1	0.6	0.7	6	24	24	6	2	2	5.9
AVG	1	1	0.9	0.7	0.5	0.8	4	17	16	4	2	1	4.1
Crow Creek near Radersburg													
90 %	12	9	6	4	8	7	10	79	81	27	13	12	22
80 %	13	10	7	5	8	7	13	88	120	34	15	14	28
50 %	15	12	9	7	9	9	20	120	160	53	23	17	38
20 %	19	15	11	9	10	12	34	160	230	93	32	23	54
AVG	16	12	9	7	9	10	23	130	170	65	24	18	41
Deep Creek below North Fork near Townsend													
90 %	8	7	5	4	6	6	10	54	45	14	8	8	15
80 %	9	8	6	5	6	7	12	66	57	18	10	9	18
50 %	10	9	8	7	8	9	20	80	92	29	14	11	25
20 %	15	13	11	9	9	10	37	110	140	51	18	14	36
AVG	12	11	9	7	8	10	26	83	100	34	15	12	27
Duck Creek near Townsend													
90 %	3	3	2	2	2	2	3	21	15	6	4	3	6
80 %	4	3	3	2	3	2	4	26	21	8	5	4	7
50 %	5	4	3	3	3	3	8	33	33	12	7	5	10
20 %	6	4	4	3	3	4	14	45	50	17	8	7	14
AVG	5	4	3	3	3	3	10	34	36	13	7	5	10
Dry Creek near Toston													
90 %	2	2	2	1	2	2	4	19	13	4	3	2	5
80 %	2	2	2	2	2	2	5	24	17	5	3	3	6
50 %	4	3	3	2	2	3	9	31	32	9	5	3	9
20 %	5	4	3	3	3	5	15	44	53	17	7	6	14
AVG	4	3	3	2	3	3	10	33	36	11	5	4	10
Elkhorn Creek near mouth near Wolf Creek													
90 %	3	3	3	2	3	3	5	13	12	4	2	2	5
80 %	3	3	3	3	3	4	5	16	14	5	3	3	5
50 %	4	4	4	3	4	4	8	20	24	9	5	4	8
20 %	6	6	5	5	4	5	11	27	36	14	7	5	11
AVG	5	5	4	4	4	5	8	21	26	10	5	4	8

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
McGuire Creek at county road near East Helena													
90 %	6	7	6	6	6	7	8	9	9	7	6	6	7
80 %	7	7	6	6	7	7	8	10	10	8	6	6	7
50 %	8	7	7	7	7	7	9	11	12	9	8	7	8
20 %	8	8	7	7	8	8	10	12	14	11	9	8	9
AVG	8	7	7	7	7	8	9	12	12	9	8	8	8
Missouri River near Toston													
90 %	3100	3700	3200	2700	3100	3200	3700	4600	5400	1800	1400	2400	3192
80 %	3500	4000	3300	3000	3400	3500	4000	5200	7100	2700	1800	2600	3675
50 %	4400	4700	3800	3400	3800	3900	5600	8700	12000	4600	2400	3400	5058
20 %	5400	5600	4300	3900	4200	4800	7200	12000	18000	7000	3300	4600	6692
AVG	4500	4800	3900	3400	3800	4100	5700	8800	12000	5100	2600	3500	5183
Prickly Pear Creek near Clancy													
90 %	17	19	16	13	16	20	33	52	41	18	13	16	23
80 %	19	20	17	16	18	23	34	63	63	28	15	17	28
50 %	28	27	22	18	21	27	50	100	120	47	29	24	43
20 %	35	31	26	24	28	38	71	130	200	88	44	37	63
AVG	29	27	23	20	24	30	52	110	130	57	30	27	47
Prickly Pear Creek at mouth near East Helena													
90 %	22	24	21	19	21	26	35	83	66	27	19	21	32
80 %	24	25	22	21	22	28	36	110	85	35	22	22	38
50 %	30	31	26	23	25	32	48	130	140	51	32	28	50
20 %	36	35	30	28	31	39	74	190	230	83	40	35	71
AVG	31	31	27	25	28	34	55	140	160	57	33	29	54
Sevenmile Creek near mouth near Helena													
90 %	1	1	1	1	1	2	3	12	9	2	1	1	3
80 %	1	1	1	1	1	2	4	15	11	2	1	1	3
50 %	2	2	2	2	2	3	6	16	21	5	2	2	5
20 %	4	4	3	3	2	4	10	24	35	12	3	3	9
AVG	3	3	2	2	2	3	7	17	24	6	2	2	6
Silver Creek at interstate near Helena													
90 %	8	8	8	7	8	9	12	16	13	8	7	8	9
80 %	8	9	8	8	8	9	12	17	17	11	7	8	10
50 %	11	11	9	8	9	11	15	23	26	15	11	10	13
20 %	12	11	10	10	11	13	19	27	35	21	14	13	16
AVG	11	11	10	9	10	11	16	24	27	16	11	11	14
Sixteenmile Creek near Maudlow													
90 %	17	18	15	13	16	20	34	58	44	18	12	15	23
80 %	18	20	16	16	17	23	37	72	72	29	14	16	29
50 %	29	28	22	18	21	28	56	120	150	52	30	24	48
20 %	37	33	27	24	29	41	83	170	260	110	48	40	75
AVG	30	28	23	20	24	31	58	130	170	64	32	28	53
Sixteenmile Creek near Ringling													
90 %	1	4	2	0.2	0.8	2	7	4	7	0	0	0	2.3
80 %	4	4	2	0.8	2	3	9	8	13	0.5	0	1	3.9
50 %	7	5	4	3	4	11	30	19	38	6	0.8	3	10.9
20 %	9	7	6	5	6	32	75	69	78	16	5	4	26
AVG	6	5	4	3	5	26	49	34	46	10	3	3	16
Sixteenmile Creek near Toston													
90 %	20	21	18	17	18	26	48	130	110	28	17	18	39
80 %	23	26	21	20	22	31	51	160	140	41	21	21	48
50 %	34	36	29	25	28	41	77	210	260	78	36	29	74
20 %	51	50	40	35	37	58	130	310	420	160	57	46	116
AVG	41	40	33	28	31	47	91	230	290	96	39	33	83

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Spokane Creek near East Helena													
90 %	3	3	3	3	3	3	3	16	11	5	3	3	5
80 %	3	3	3	3	3	3	5	21	15	6	4	3	6
50 %	4	4	4	3	4	4	9	28	27	9	5	4	9
20 %	6	5	4	4	4	5	15	39	42	14	7	5	12
AVG	5	4	4	3	4	5	10	29	29	10	5	5	9
Tenmile Creek at mouth near East Helena													
90 %	2	3	2	2	2	3	7	22	16	5	3	2	6
80 %	3	3	2	2	2	3	8	28	25	7	4	3	8
50 %	5	5	3	3	3	5	14	48	61	14	6	5	14
20 %	8	6	5	4	5	9	24	73	110	36	12	9	25
AVG	6	5	4	3	4	6	15	53	69	19	7	6	16
Tenmile Creek near Helena													
90 %	1	3	2	3	3	3	9	42	18	5	0.3	0.8	7.5
80 %	3	4	3	4	4	5	14	53	27	7	0.6	1	10.5
50 %	5	7	6	5	6	7	30	89	85	13	2	3	22
20 %	12	13	10	10	7	11	44	120	150	22	8	7	34
AVG	7	9	7	7	6	8	33	97	97	17	5	5	25
Tenmile Creek near Rimini													
90 %	0.3	0.4	0.4	0.3	0.3	0.6	3	37	16	1	0.4	0.3	5.0
80 %	0.5	0.6	0.6	0.5	0.6	0.9	6	54	25	2	0.5	0.5	7.6
50 %	1	1	1	1	1	2	13	79	70	8	1	1	15
20 %	3	3	2	2	2	3	24	100	110	19	3	3	23
AVG	3	2	2	1	1	2	16	84	76	12	2	2	17
Trout Creek at mouth near East Helena													
90 %	13	12	11	10	11	13	15	29	25	13	11	12	15
80 %	13	12	11	11	11	14	16	35	30	15	11	12	16
50 %	15	14	13	11	12	15	18	40	48	20	15	14	20
20 %	15	16	14	13	14	18	23	56	74	29	17	15	25
AVG	14	14	13	12	13	16	19	42	53	22	15	13	20
Willow Creek below Elkhorn Creek near Wolf Creek													
90 %	2	2	2	2	1	1	3	27	19	4	3	2	6
80 %	2	2	2	2	2	2	4	31	21	4	3	2	6
50 %	3	3	3	3	2	3	7	34	39	8	4	3	9
20 %	5	6	4	3	2	3	15	50	63	19	6	4	15
AVG	4	4	3	3	2	3	10	36	43	10	4	3	10
MISSOURI RIVER DRAINAGE - HOLTER DAM TO BELT CREEK													
Canyon Creek below Cottonwood Creek near Canyon Creek													
90 %	4	4	6	4	6	10	12	49	44	6	3	5	13
80 %	5	6	8	5	8	14	20	59	58	8	4	6	17
50 %	8	9	13	9	11	26	45	98	170	24	5	10	36
20 %	15	16	19	12	15	49	76	190	330	64	8	15	67
AVG	11	11	14	9	12	30	48	120	190	35	6	10	41
Little Prickly Pear Creek near Canyon Creek													
90 %	12	11	15	12	16	22	20	28	48	6	2	13	17
80 %	13	15	20	14	19	26	32	43	61	13	3	15	23
50 %	18	20	27	19	23	39	60	100	160	31	5	21	44
20 %	25	26	33	24	28	56	110	180	310	69	13	27	75
AVG	20	21	26	20	24	43	67	120	180	43	8	21	49
Little Prickly Pear Creek near Wolf Creek													
90 %	35	42	45	32	41	44	76	130	70	51	20	30	51
80 %	44	49	50	38	49	60	92	170	95	62	27	36	64
50 %	58	64	57	50	62	79	150	330	190	92	54	59	104
20 %	85	79	67	61	77	100	230	560	300	160	97	84	158
AVG	65	64	58	51	65	81	180	380	220	110	76	63	118

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Lyons Creek near Wolf Creek													
90 %	5	5	5	4	5	5	6	24	19	6	3	3	8
80 %	5	6	5	5	5	6	9	28	23	8	4	4	9
50 %	7	7	6	5	6	8	13	34	41	13	7	6	13
20 %	9	9	8	7	7	10	19	49	61	23	9	7	18
AVG	7	7	7	6	6	9	14	37	45	16	7	6	14
Missouri River near Great Falls													
90 %	4100	4200	4300	3800	3700	4300	4600	6100	6300	3900	3200	3300	4317
80 %	5000	4900	4800	4600	4700	5100	5000	7600	8500	4900	3800	3800	5225
50 %	5500	5600	5800	5400	5900	6100	7600	11000	15000	7800	5100	4900	7142
20 %	6800	7300	6800	7100	7500	8100	10000	16000	21000	12000	7200	6300	9675
AVG	5800	5900	5800	5700	5900	6500	7700	12000	16000	8500	5400	5100	7525
Missouri River near Ulm													
90 %	3200	3500	4000	3700	3200	3700	3800	5200	4500	3100	2300	2500	3558
80 %	3700	4200	4500	4200	4400	4500	4200	6300	7200	4000	2700	3100	4417
50 %	4700	5000	5300	5300	5100	5700	6700	9200	12000	6600	4100	4200	6158
20 %	6000	6200	6100	6400	6500	6800	8800	13000	18000	10000	5900	5300	8250
AVG	4800	5300	5400	5300	5300	5700	6800	9800	13000	7300	4300	4300	6442
Stickney Creek near Craig													
90 %	0	0	0	0	0	0	0	12	8	0	0	0	2
80 %	0	0	0	0	0	0	1	17	14	0	0	0	3
50 %	0	0	0	0	0	0	5	31	31	6	0	0	6
20 %	0	0	0	0	0	0	12	46	51	13	0	0	10
AVG	0	0	0	0	0	0	7	34	35	7	0	0	7
Virginia Creek at mouth near Canyon Creek													
90 %	3	3	4	3	4	7	7	25	22	5	3	4	8
80 %	4	4	6	4	6	9	12	31	30	7	3	5	10
50 %	6	7	9	6	7	15	25	54	77	15	4	7	19
20 %	9	9	11	7	10	28	38	94	130	31	7	11	32
AVG	7	7	8	6	8	17	25	62	85	20	5	8	22
Wegner Creek near Craig													
90 %	0	0	0	0	0	0	0	15	8	0	0	0	2
80 %	0	0	0	0	0	0	2	23	15	0	0	0	3
50 %	0	0	0	0	0	0	7	39	34	6	0	0	7
20 %	0	0	0	0	0	0	15	59	56	13	0	0	12
AVG	0	0	0	0	0	0	8	41	38	8	0	0	8
Wolf Creek at mouth at Wolf Creek													
90 %	2	2	2	2	2	2	5	29	20	5	3	2	6
80 %	3	3	2	2	2	3	6	36	25	6	3	3	8
50 %	4	4	3	3	3	4	11	41	45	11	5	4	12
20 %	7	6	4	4	4	5	20	58	74	24	8	6	18
AVG	5	4	4	3	3	4	13	42	51	14	6	5	13
DEARBORN RIVER DRAINAGE													
Dearborn River near Craig													
90 %	41	46	40	36	42	42	31	270	140	56	17	20	65
80 %	48	51	47	41	46	54	91	360	300	89	33	32	99
50 %	70	68	62	53	57	77	180	670	710	180	68	52	187
20 %	91	92	83	67	71	100	350	1000	1100	340	100	75	289
AVG	72	72	67	56	61	84	200	680	810	210	70	56	203
Flat Creek above Slew Creek near Craig													
90 %	7	8	6	6	7	7	7	31	28	11	5	4	11
80 %	8	9	8	7	7	10	18	41	52	17	7	6	16
50 %	13	12	11	9	10	15	34	100	120	34	13	9	32
20 %	17	17	14	11	13	22	53	160	160	61	21	14	47
AVG	13	13	11	9	11	16	35	110	130	42	14	10	34

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Middle Fork Dearborn River at Highway 200 near Wolf Creek													
90 %	7	7	6	5	6	5	5	64	42	15	8	6	15
80 %	8	8	7	6	6	7	13	82	61	19	10	8	20
50 %	11	10	9	8	8	9	27	120	110	33	14	11	31
20 %	16	12	11	9	10	12	50	160	170	53	20	15	45
AVG	13	10	9	8	8	10	32	120	130	36	15	12	34
Sheep Creek at mouth near Cascade													
90 %	13	10	8	6	7	7	11	57	68	33	17	14	21
80 %	16	12	9	8	8	8	15	77	110	53	24	19	30
50 %	23	17	12	11	10	9	31	190	220	80	36	26	55
20 %	25	18	13	12	13	12	56	310	310	97	56	36	80
AVG	21	15	11	10	10	9	36	210	230	84	38	28	58
South Fork Dearborn River at Highway 434 near Wolf Creek													
90 %	6	6	5	4	5	4	4	51	34	13	7	5	12
80 %	7	7	6	5	5	6	12	66	56	17	9	7	17
50 %	10	9	8	7	7	8	27	120	120	31	13	9	31
20 %	14	11	9	8	9	12	50	180	170	53	18	14	46
AVG	11	9	8	6	7	9	31	120	130	36	14	11	33
SMITH RIVER DRAINAGE													
Big Birch Creek at mouth near White Sulphur Springs													
90 %	17	21	13	10	12	20	43	39	37	14	5	16	21
80 %	20	22	14	12	15	31	51	49	65	23	8	18	27
50 %	32	28	21	17	26	49	81	130	270	63	22	25	64
20 %	41	31	27	26	57	100	100	250	410	100	40	32	101
AVG	29	25	20	18	33	60	76	170	260	79	20	25	68
Camas Creek near mouth near White Sulphur Springs													
90 %	3	3	3	3	3	4	7	38	27	7	4	3	9
80 %	4	5	4	3	4	5	10	47	32	8	5	4	11
50 %	5	6	5	5	5	7	16	52	58	15	8	6	16
20 %	9	9	7	6	6	10	29	76	96	32	11	9	25
AVG	7	7	6	5	5	8	20	54	65	19	8	7	18
Eagle Creek near mouth near White Sulphur Springs													
90 %	2	1	1	1	1	1	3	29	22	6	3	2	6
80 %	2	2	2	2	2	1	4	37	28	8	4	3	8
50 %	3	3	2	3	2	2	8	47	53	13	6	4	12
20 %	6	4	3	3	2	2	19	71	84	24	8	6	19
AVG	5	4	3	2	2	2	12	50	58	15	6	5	14
Hound Creek near mouth near Cascade													
90 %	13	10	8	9	9	8	24	99	83	27	16	15	27
80 %	15	13	11	10	12	11	31	130	120	41	22	17	36
50 %	21	18	15	14	14	17	61	270	220	75	36	25	66
20 %	30	25	20	18	16	23	100	430	360	120	49	33	102
AVG	24	21	16	15	14	19	70	300	260	82	37	26	74
Newlan Creek below Charcoal Gulch near White Sulphur Springs													
90 %	3	4	3	3	3	4	7	16	13	5	3	3	6
80 %	3	5	4	3	4	5	11	20	18	7	3	3	7
50 %	5	6	5	4	5	7	16	30	35	13	8	6	12
20 %	8	8	6	5	7	13	22	48	52	23	13	9	18
AVG	6	6	5	4	5	9	17	33	38	16	8	6	13
North Fork Smith River at Highway 89 near White Sulphur Springs													
90 %	3	3	2	2	2	1	3	47	31	9	6	4	9
80 %	4	4	3	3	2	2	5	80	48	13	8	6	15
50 %	6	7	4	4	3	2	11	330	160	23	12	9	48
20 %	11	14	6	5	3	2	24	820	340	40	21	13	108
AVG	8	8	4	4	3	2	16	410	190	25	13	9	58

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Rock Creek below Buffalo Canyon near White Sulphur Springs													
90 %	8	6	5	5	5	6	9	51	42	15	9	8	14
80 %	9	8	6	6	6	6	11	63	54	21	12	10	18
50 %	11	10	8	8	8	8	20	83	94	31	16	12	26
20 %	15	13	11	10	9	10	37	120	140	49	22	16	38
AVG	13	11	9	8	7	9	25	88	100	35	17	13	28
Sheep Creek near mouth near White Sulphur Springs													
90 %	16	12	10	10	9	10	18	150	130	41	21	17	37
80 %	19	16	13	12	12	12	25	190	190	62	29	23	50
50 %	26	22	18	17	16	16	51	290	350	100	41	30	81
20 %	38	31	24	22	18	18	110	460	530	160	62	42	126
AVG	31	25	20	17	15	17	69	320	380	110	44	33	90
Sheep Creek near White Sulphur Springs													
90 %	11	9	7	6	7	7	10	55	49	22	14	12	17
80 %	12	10	8	7	7	8	12	64	63	30	18	14	21
50 %	15	13	11	10	9	9	18	89	100	41	23	18	30
20 %	18	15	12	11	11	11	30	130	160	55	30	22	42
AVG	16	13	11	9	9	9	21	96	110	43	23	18	32
Smith River below forks near White Sulphur Springs													
90 %	11	9	8	7	6	5	9	110	72	23	15	11	24
80 %	12	12	9	8	7	6	14	140	98	31	19	15	31
50 %	18	18	12	11	9	8	27	240	190	49	27	22	53
20 %	26	29	16	13	10	8	59	380	330	76	39	29	85
AVG	20	20	13	11	9	8	39	260	220	51	29	22	58
Smith River near Eden													
90 %	92	89	54	51	66	82	180	360	360	96	58	62	129
80 %	110	100	66	61	88	110	210	460	530	190	83	85	174
50 %	140	130	110	93	130	160	360	860	920	370	140	120	294
20 %	190	200	150	140	190	240	560	1500	1400	740	230	190	478
AVG	170	150	120	100	150	170	420	990	1100	450	160	150	344
Smith River near Fort Logan													
90 %	90	98	79	73	77	93	130	160	120	81	41	90	94
80 %	96	100	84	80	88	110	140	200	180	100	55	98	111
50 %	120	110	98	95	110	140	190	270	390	170	100	110	159
20 %	140	120	110	110	150	180	260	380	540	230	130	120	206
AVG	120	110	99	95	120	150	210	320	390	190	95	110	167
South Fork Smith River at mouth near White Sulphur Springs													
90 %	8	9	7	6	6	9	15	38	28	10	5	8	12
80 %	9	10	7	7	8	12	18	49	39	13	7	9	16
50 %	12	11	10	9	11	16	27	67	82	25	12	11	24
20 %	17	14	12	12	17	25	42	100	130	42	16	14	37
AVG	13	12	10	9	12	19	30	73	88	29	11	12	26
Tenderfoot Creek below South Fork near White Sulphur Springs													
90 %	13	11	9	7	8	7	11	110	85	33	18	15	27
80 %	16	13	10	9	9	8	17	140	120	48	24	19	36
50 %	21	16	13	12	11	10	36	210	220	72	33	25	57
20 %	27	19	15	14	14	11	73	310	330	99	47	34	83
AVG	23	16	13	11	11	10	46	220	240	76	35	27	61
SUN RIVER DRAINAGE													
Elk Creek near Augusta													
90 %	19	21	18	12	18	18	21	55	98	32	20	20	29
80 %	32	25	19	17	22	19	25	86	190	52	26	23	45
50 %	45	33	23	26	30	28	36	220	310	78	37	30	75
20 %	65	53	27	37	46	53	66	330	490	150	49	38	117
AVG	48	39	24	31	33	34	45	220	340	100	38	31	82

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Ford Creek near Augusta													
90 %	12	6	4	4	5	7	8	29	29	27	12	12	13
80 %	13	7	6	6	6	7	9	37	45	31	15	14	16
50 %	16	10	10	8	8	9	18	61	62	40	19	17	23
20 %	18	14	13	10	11	15	23	89	110	56	27	21	34
AVG	16	11	10	8	9	12	17	64	81	44	20	18	26
North Fork Sun River near Augusta													
90 %	65	67	59	50	47	48	67	810	720	260	100	90	199
80 %	71	69	63	54	52	53	88	960	830	310	130	95	231
50 %	94	86	71	65	64	61	160	1200	1300	460	160	110	319
20 %	140	110	94	74	74	80	300	1500	2000	700	210	140	452
AVG	110	92	79	66	65	68	200	1300	1400	500	160	120	347
North Fork Willow Creek below Cutrock Creek near Augusta													
90 %	3	3	2	2	2	3	4	10	8	3	2	2	4
80 %	3	3	3	2	3	3	4	12	9	3	2	3	4
50 %	3	3	3	3	3	4	5	13	16	5	3	3	5
20 %	4	4	3	3	4	5	7	18	24	8	4	3	7
AVG	3	3	3	3	3	4	6	14	17	6	3	3	6
Smith Creek near Augusta													
90 %	6	4	5	4	4	8	6	42	34	25	6	4	12
80 %	7	6	6	5	5	10	7	52	43	30	8	6	15
50 %	14	12	8	7	8	13	17	70	69	47	12	9	24
20 %	21	16	12	10	16	17	34	100	110	59	17	16	36
AVG	15	12	10	7	10	17	25	75	86	48	13	11	27
Sun River at Simms													
90 %	110	140	130	120	120	48	100	160	420	66	55	49	126
80 %	130	160	140	140	130	84	150	330	710	96	87	68	185
50 %	190	210	180	180	180	140	300	790	1400	270	150	120	342
20 %	250	240	210	240	250	250	610	1700	3200	600	240	180	664
AVG	200	210	190	190	190	170	390	1100	2100	420	170	130	455
Sun River below diversion dam near Augusta													
90 %	80	60	73	75	63	61	57	290	360	71	64	54	109
80 %	96	79	85	82	89	98	110	340	690	160	73	64	164
50 %	130	130	130	110	120	120	230	770	1300	250	86	100	290
20 %	190	160	170	160	160	190	420	1400	2900	480	140	130	542
AVG	140	130	130	120	120	140	290	910	1800	330	110	110	361
Sun River near Augusta													
90 %	100	55	41	26	29	58	140	1300	1300	390	760	240	370
80 %	110	170	99	92	140	150	230	1900	1900	680	840	260	548
50 %	110	240	180	170	180	200	520	2900	3000	1000	1100	370	831
20 %	120	360	260	240	260	310	940	3800	4700	1700	1300	540	1211
AVG	110	270	200	180	220	230	600	2800	3300	1200	1100	390	883
Willow Creek near Anderson Lake near Augusta													
90 %	2	2	2	1	2	2	4	21	14	3	2	2	5
80 %	2	2	2	2	2	2	4	25	17	4	3	2	6
50 %	3	3	2	2	2	3	7	27	30	8	4	3	8
20 %	5	4	3	3	3	4	13	38	48	15	5	4	12
AVG	4	3	3	2	2	3	9	28	33	9	4	3	9
BELT CREEK DRAINAGE													
Belt Creek near Monarch													
90 %	35	29	18	14	15	19	34	230	250	75	36	36	66
80 %	41	31	22	17	21	24	46	340	330	110	56	47	90
50 %	52	45	37	29	29	31	88	550	570	200	79	63	148
20 %	74	62	47	38	41	43	180	950	1000	320	120	100	248
AVG	65	49	35	29	31	35	120	630	700	220	87	74	173

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Belt Creek near Portage													
90 %	17	14	10	7	8	9	30	260	250	57	16	14	58
80 %	21	18	12	9	11	13	46	320	390	85	27	18	81
50 %	37	31	22	17	17	24	100	540	710	150	54	35	145
20 %	61	48	34	27	28	37	270	1200	1700	330	91	60	324
AVG	46	34	24	17	19	27	140	770	1100	220	59	42	208
Big Otter Creek above Never Sweat Creek near Raynesford													
90 %	2	4	4	4	4	3	7	21	14	6	2	1	6
80 %	4	5	5	4	5	6	9	26	17	7	4	2	8
50 %	5	5	5	5	6	9	12	30	29	10	6	5	11
20 %	6	7	6	6	8	15	18	42	50	14	8	6	16
AVG	5	6	6	5	7	13	14	31	33	11	7	5	12
Dry Fork at mouth at Monarch													
90 %	7	6	5	4	4	5	9	62	51	15	8	7	15
80 %	8	7	5	5	5	6	12	76	66	21	11	9	19
50 %	11	10	8	7	7	8	23	100	110	37	16	12	29
20 %	17	14	11	9	9	9	44	150	170	60	23	19	45
AVG	14	11	9	7	7	8	30	110	130	42	17	14	33
Logging Creek at Logging Creek Campground near Monarch													
90 %	6	6	5	4	4	5	7	25	19	10	7	6	9
80 %	7	6	5	4	5	5	8	32	25	13	8	7	10
50 %	9	8	6	6	6	6	12	44	40	17	11	9	14
20 %	10	8	7	6	7	7	20	59	60	21	14	12	19
AVG	9	7	6	5	6	6	14	45	44	18	11	10	15
Pilgrim Creek at mouth near Monarch													
90 %	5	5	4	3	4	5	12	46	31	11	6	5	11
80 %	6	6	4	4	5	5	16	61	45	14	7	7	15
50 %	9	7	5	6	6	7	26	93	79	23	11	9	23
20 %	13	10	7	8	8	10	40	130	120	37	16	13	34
AVG	10	8	6	6	7	8	28	96	88	27	12	10	26
Tillinghast Creek above Joice Creek near Monarch													
90 %	6	6	4	3	4	5	7	30	26	11	7	6	10
80 %	7	6	5	4	5	5	9	38	33	15	9	8	12
50 %	9	8	7	6	6	6	15	53	54	22	12	10	17
20 %	11	10	8	7	8	8	24	74	80	30	16	14	24
AVG	10	8	7	6	6	7	17	56	60	24	13	11	19
MARIAS RIVER DRAINAGE													
Birch Creek at Swift Dam near Valier													
90 %	18	0.3	0	0.6	0.2	2	6	63	110	150	9	53	34
80 %	25	1	1	1	2	2	7	150	270	170	21	59	59
50 %	55	4	7	8	8	4	13	240	370	240	98	91	95
20 %	110	19	17	13	43	36	110	370	630	430	160	170	176
AVG	64	12	13	8	27	16	54	250	500	300	100	110	121
Birch Creek near Valier													
90 %	29	25	34	18	38	22	17	22	31	19	12	13	23
80 %	36	30	37	25	41	29	23	32	55	25	14	16	30
50 %	47	44	39	34	51	71	71	68	99	43	20	28	51
20 %	53	57	51	45	65	210	150	140	220	97	33	50	98
AVG	45	44	44	35	55	160	100	94	140	62	23	37	70
Cut Bank Creek near Browning													
90 %	23	25	13	5	11	21	67	340	310	74	38	24	79
80 %	31	34	22	17	24	38	83	360	370	130	49	36	100
50 %	56	52	36	31	35	71	120	410	470	170	63	44	130
20 %	94	78	59	49	62	200	150	430	680	260	90	60	184
AVG	66	56	42	33	51	120	120	400	530	190	69	55	144

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Cut Bank Creek at Cut Bank													
90 %	30	31	17	17	18	37	80	280	280	78	29	26	77
80 %	35	37	23	23	25	44	94	360	350	110	35	40	98
50 %	58	59	35	33	35	94	200	550	510	190	66	51	157
20 %	110	85	61	50	91	250	360	670	810	350	110	100	254
AVG	77	63	44	38	57	150	240	520	600	230	77	67	180
Dupuyer Creek below Scoffin Creek near Dupuyer													
90 %	6	5	7	6	7	10	11	63	47	10	6	7	15
80 %	7	8	9	7	9	12	18	77	60	13	7	8	20
50 %	10	10	13	9	11	20	35	100	120	27	8	12	31
20 %	16	15	16	12	14	32	57	150	200	55	12	16	50
AVG	12	12	13	10	12	22	39	110	130	34	10	13	35
Marias River above Tiber Reservoir near Shelby													
90 %	210	220	170	140	150	270	490	1700	1400	370	180	150	454
80 %	240	240	190	180	190	310	610	2100	1700	570	220	220	564
50 %	370	370	290	240	310	470	1200	3000	2900	920	370	330	898
20 %	620	510	440	360	600	1000	1700	4300	5000	1700	590	590	1451
AVG	460	400	340	280	370	710	1200	3200	3800	1200	420	400	1065
Marias River at Sullivan Bridge near Cut Bank													
90 %	180	190	150	120	130	230	400	1300	1100	310	150	130	366
80 %	210	210	170	150	160	260	500	1600	1300	460	190	190	450
50 %	310	310	240	210	260	390	960	2300	2200	730	310	280	708
20 %	510	420	360	300	490	830	1300	3200	3600	1300	480	480	1106
AVG	380	330	280	230	310	570	970	2400	2800	950	350	330	825
Marias River near Loma													
90 %	470	330	110	110	140	130	400	1000	570	460	350	330	367
80 %	540	370	180	160	220	220	490	1100	750	680	540	420	472
50 %	810	630	370	300	420	390	830	1400	1500	1300	980	720	804
20 %	1100	840	650	500	630	750	1300	1700	2600	2000	1600	1100	1231
AVG	860	640	390	330	420	480	890	1400	1900	1300	1100	880	882
Marias River near Shelby													
90 %	180	190	150	120	130	230	420	1400	1200	320	150	130	385
80 %	210	210	170	150	160	260	520	1800	1500	490	190	190	488
50 %	320	320	250	210	260	400	1100	2600	2500	790	320	290	780
20 %	530	430	370	310	510	900	1500	3700	4300	1500	510	500	1255
AVG	390	340	290	240	320	610	1100	2700	3200	1000	360	340	908
North Fork Badger Creek near Browning													
90 %	9	8	9	7	7	8	18	140	100	28	17	13	30
80 %	11	10	10	8	8	9	24	150	130	39	19	14	36
50 %	16	15	13	11	11	12	38	200	190	59	26	17	51
20 %	25	21	18	15	14	15	59	240	270	91	33	22	69
AVG	19	16	15	12	11	12	42	200	210	65	26	18	54
North Fork Dupuyer Creek near Dupuyer													
90 %	2	2	2	2	2	2	5	32	23	7	5	3	7
80 %	3	3	3	2	2	3	7	38	29	10	5	4	9
50 %	5	4	3	3	3	3	11	50	48	15	8	5	13
20 %	7	6	5	4	4	5	17	65	68	22	10	7	18
AVG	5	4	4	3	3	4	12	52	52	16	8	5	14
South Fork Badger Creek near Browning													
90 %	9	9	10	8	8	9	19	150	120	31	19	14	34
80 %	13	11	11	9	9	10	26	170	140	43	21	15	40
50 %	18	16	14	12	12	13	41	210	210	65	28	18	55
20 %	28	23	19	16	15	16	64	270	300	100	36	23	76
AVG	20	17	16	13	12	14	45	220	230	71	28	20	59

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
South Fork Dupuyer Creek near Dupuyer													
90 %	2	2	2	2	2	2	4	22	17	6	4	3	6
80 %	3	2	2	2	2	2	6	27	21	7	4	3	7
50 %	4	3	3	3	2	3	10	38	36	11	6	4	10
20 %	6	5	4	3	3	4	15	50	52	17	8	6	14
AVG	5	4	3	3	3	3	10	39	39	13	6	5	11
South Fork Two Medicine River near East Glacier													
90 %	12	10	9	8	6	6	10	130	92	25	17	13	28
80 %	14	14	10	9	7	7	15	150	120	35	22	17	35
50 %	21	24	14	12	9	8	28	300	240	59	34	28	65
20 %	31	37	19	14	11	10	61	520	380	95	52	36	106
AVG	23	23	15	12	9	9	39	340	260	63	36	27	71
TETON RIVER DRAINAGE													
Deep Creek near Choteau													
90 %	7	7	7	6	7	8	12	19	15	7	5	6	9
80 %	8	8	7	7	7	9	13	22	22	11	6	7	11
50 %	11	11	9	7	8	10	18	34	39	17	11	9	15
20 %	13	12	10	9	11	14	25	43	60	30	16	14	21
AVG	11	10	9	8	9	11	19	36	43	20	12	11	17
McDonald Creek near Strabane													
90 %	9	9	8	8	8	10	11	14	14	11	9	9	10
80 %	9	10	9	9	9	10	11	15	15	12	9	10	11
50 %	10	10	9	9	9	11	13	16	16	13	11	10	11
20 %	12	11	11	10	11	14	15	16	17	15	12	12	13
AVG	11	11	10	10	10	12	14	16	16	13	11	11	12
North Fork Deep Creek near Choteau													
90 %	3	3	3	2	3	3	7	40	30	9	6	4	9
80 %	4	4	3	3	3	3	9	47	37	12	7	5	11
50 %	6	5	4	4	4	5	15	63	61	19	10	6	17
20 %	9	7	6	5	5	6	23	82	87	29	13	9	23
AVG	7	6	5	4	4	5	16	65	66	21	10	7	18
South Fork Deep Creek near Choteau													
90 %	3	3	3	2	2	3	7	37	28	9	6	4	9
80 %	4	4	3	3	3	3	9	44	35	12	6	5	11
50 %	6	5	4	4	4	4	14	60	57	18	9	6	16
20 %	9	7	6	5	5	6	22	78	83	27	12	8	22
AVG	7	5	5	4	4	5	15	62	63	20	9	7	17
Teton River near Dutton													
90 %	28	34	30	37	40	62	73	59	64	32	16	26	42
80 %	40	44	39	42	47	72	100	110	140	64	45	39	65
50 %	63	70	58	55	67	120	150	340	320	140	67	59	126
20 %	110	97	94	66	95	200	250	440	560	270	120	90	199
AVG	75	76	68	55	86	170	180	330	420	170	80	69	148
Teton River near Strabane													
90 %	13	7	8	7	4	9	6	26	36	21	17	19	15
80 %	15	16	15	14	6	16	11	46	59	32	22	20	22
50 %	20	20	19	17	14	11	25	86	99	82	30	24	37
20 %	24	25	23	21	18	13	47	120	140	84	43	29	49
AVG	20	21	19	17	13	12	30	87	100	61	33	25	36
MISSOURI RIVER DRAINAGE - BELT CREEK TO FORT PECK RESERVOIR													
Cow Creek below forks near Cleveland													
90 %	3	2	2	2	2	2	4	12	12	5	3	3	4
80 %	3	3	3	2	2	3	5	15	16	6	4	3	5
50 %	4	4	3	3	3	4	8	21	28	11	6	4	8
20 %	6	5	4	3	3	5	12	31	40	16	9	6	12

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Highwood Creek below Smith Creek near Highwood													
90 %	5	4	4	3	3	3	4	55	36	12	7	6	12
80 %	6	5	4	4	4	3	7	70	47	15	9	7	15
50 %	7	6	5	5	4	3	15	84	78	23	11	9	21
20 %	10	7	6	6	5	4	33	110	130	36	15	12	31
AVG	9	6	5	5	4	4	21	85	88	25	12	10	23
Missouri River at Fort Benton													
90 %	3800	4000	4300	3800	3700	4300	4800	6700	6800	3900	3200	3300	4383
80 %	4300	5000	4800	4700	4700	5300	5100	8000	9000	5200	3800	3700	5300
50 %	5400	5600	5800	5500	6000	6300	7700	12000	16000	7900	5200	4900	7358
20 %	6900	7200	7000	7200	7600	8000	10000	18000	23000	12000	6900	6300	10008
AVG	5600	6000	5900	5800	6100	6600	7900	12000	17000	8800	5400	5200	7692
Missouri River at Virgelle													
90 %	4000	4800	4600	4100	3900	4600	5300	7100	7800	4400	3500	3900	4833
80 %	4900	5400	5200	4900	5200	5700	6200	9900	12000	5600	4300	4300	6133
50 %	6100	6400	6500	6000	6700	7200	8500	13000	18000	10000	5800	5400	8300
20 %	7700	7600	7400	7700	8400	9100	12000	19000	26000	14000	8100	7100	11175
AVG	6300	6600	6400	6300	6600	7600	9100	14000	20000	10000	6200	5900	8750
Missouri River near Landusky													
90 %	4300	5100	4900	4600	4200	5500	6000	7700	8400	5000	3900	4300	5325
80 %	5300	5900	5600	5200	5500	6600	7000	10000	13000	6200	4700	4600	6633
50 %	6700	6800	6900	6600	7200	8400	9200	14000	20000	11000	6600	5900	9108
20 %	8100	8000	7900	8300	9300	11000	14000	21000	29000	15000	8700	7700	12333
AVG	6800	7100	6900	6700	7300	8900	10000	16000	22000	12000	6800	6400	9742
Shonkin Creek below Bishop Creek near Highwood													
90 %	3	3	2	2	2	1	2	43	25	10	6	4	9
80 %	4	3	3	3	3	2	5	57	35	12	7	5	12
50 %	5	4	3	3	3	2	13	79	61	18	9	7	17
20 %	8	4	3	4	3	2	29	110	100	26	11	9	26
AVG	6	4	3	3	3	2	18	81	70	18	10	8	19
JUDITH RIVER DRAINAGE													
Beaver Creek at county road near Lewistown													
90 %	2	5	6	5	5	3	15	30	21	9	3	2	9
80 %	4	6	7	6	8	10	20	39	27	11	5	3	12
50 %	7	8	9	7	11	26	28	50	49	16	8	6	19
20 %	9	11	10	10	17	61	39	71	79	25	13	8	29
AVG	7	9	9	8	15	47	33	55	56	18	10	7	23
Big Spring Creek above Cottonwood Creek near Hanover													
90 %	110	100	92	96	100	90	130	220	170	140	120	120	124
80 %	120	110	100	98	100	99	140	260	210	160	130	120	137
50 %	130	120	110	100	110	110	180	320	260	190	160	140	161
20 %	130	120	120	110	110	130	220	380	320	210	170	150	181
AVG	130	120	110	110	110	110	190	330	280	190	160	140	165
Big Spring Creek at mouth near Lewistown													
90 %	98	85	70	76	83	68	130	350	220	150	120	110	130
80 %	110	94	82	80	88	81	150	460	310	190	140	120	159
50 %	130	110	96	89	95	98	230	690	460	260	180	150	216
20 %	140	120	110	100	100	130	330	900	680	330	210	170	277
AVG	130	110	98	92	94	110	250	710	540	270	180	150	228
Cottonwood Creek at Highway 200 near Lewistown													
90 %	3	2	2	2	1	1	3	31	27	7	4	3	7
80 %	3	3	2	2	2	2	5	40	37	10	5	4	10
50 %	4	4	3	3	3	2	11	66	73	20	7	5	17
20 %	7	5	4	4	3	3	23	120	120	35	11	9	29
AVG	6	4	3	3	2	3	14	75	87	23	8	7	20

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
East Fork Big Spring Creek at mouth near Lewistown													
90 %	5	4	3	4	4	3	10	44	35	10	6	6	11
80 %	6	5	4	4	5	5	12	54	46	14	8	6	14
50 %	8	7	6	6	6	7	23	89	83	26	13	9	24
20 %	12	10	9	8	6	9	38	140	130	45	18	12	36
AVG	9	8	7	6	6	8	27	98	96	30	13	10	26
Judith River above Courtneys Creek at Utica													
90 %	7	5	5	5	4	3	5	100	77	23	12	9	21
80 %	10	8	7	6	5	4	10	120	100	33	16	12	28
50 %	13	10	9	8	7	6	26	170	190	62	23	16	45
20 %	21	15	12	10	8	4	60	230	300	100	34	24	68
AVG	17	12	10	8	6	6	39	170	210	67	25	19	49
Judith River near Winifred													
90 %	240	240	240	240	240	260	260	280	250	260	240	240	249
80 %	240	240	250	240	250	310	290	360	300	320	250	240	274
50 %	420	450	470	490	530	590	500	530	550	560	480	470	503
20 %	550	580	590	600	640	710	730	720	720	670	670	640	652
AVG	410	420	420	430	480	540	520	540	550	550	470	440	481
Lost Creek at mouth near Utica													
90 %	5	5	5	4	4	5	10	46	36	12	7	6	12
80 %	7	6	5	5	5	6	13	55	47	16	9	7	15
50 %	9	8	7	6	6	7	21	79	79	26	13	10	23
20 %	13	11	9	8	8	10	33	110	120	40	18	13	33
AVG	10	9	7	6	6	8	23	83	86	29	14	11	24
Middle Fork Judith River near Utica													
90 %	4	2	0.3	0	0	0	6	71	120	25	4	2	19.5
80 %	5	3	0.5	0	0	0.2	8	96	160	34	5	3	26.2
50 %	8	4	2	0.1	0.1	0.7	12	130	220	66	14	11	39.0
20 %	14	7	3	0.3	0.8	2	18	160	350	90	31	19	57.9
AVG	10	4	2	0.3	0.5	1	14	130	250	69	18	12	42.6
South Fork Judith River at Indian Hill Campground near Utica													
90 %	1	1	1	1	1	0.7	1	27	18	5	3	2	5.1
80 %	2	1	1	1	1	0.8	3	32	24	5	4	2	6.4
50 %	2	2	2	2	2	1	6	37	42	9	4	3	9
20 %	4	2	2	2	2	1	15	52	74	15	5	4	15
AVG	3	2	2	2	1	1	9	37	48	10	4	4	10
Warm Springs Creek above Meadow Creek near Hilger													
90 %	100	97	96	96	95	97	95	92	94	98	100	100	97
80 %	100	100	100	100	100	100	100	98	100	100	100	110	101
50 %	110	110	100	110	100	110	110	100	110	110	110	110	108
20 %	120	110	110	110	110	110	110	110	120	110	110	110	112
AVG	110	110	100	100	100	110	110	100	110	110	110	110	107
Yogo Creek at mouth near Utica													
90 %	0.3	0.2	0.4	0.7	0.3	0.6	2	25	18	3	1	0.5	4.3
80 %	0.5	0.7	0.7	0.7	0.8	0.9	3	29	20	4	2	0.7	5.2
50 %	1	1	1	2	1	3	6	29	36	8	2	2	8
20 %	4	4	3	2	2	3	14	39	59	20	3	3	13
AVG	3	3	2	2	1	3	9	28	41	10	2	2	9
MUSSELSHELL RIVER DRAINAGE													
Alabaugh Creek at mouth near Lennep													
90 %	2	2	1	1	1	1	2	23	18	6	3	2	5
80 %	3	2	2	2	2	1	4	30	25	8	4	3	7
50 %	4	3	2	2	2	2	8	43	49	14	6	4	12
20 %	5	4	3	3	2	2	17	68	76	22	9	6	18
AVG	4	3	3	2	2	2	11	47	54	15	6	5	13

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
American Fork near Harlowton													
90 %	0	0	1	0.8	0.1	0	0	0.1	0.1	0	0	0	0.2
80 %	0.2	0	2	1	0.3	0	0.3	0.8	2	0.3	0	0	0.6
50 %	2	2	3	2	1	1	3	3	11	2	0.5	0.7	2.6
20 %	5	4	5	3	2	5	7	10	70	9	2	2	10
AVG	3	2	3	2	2	2	4	7	56	5	1	0.9	7.3
Big Elk Creek at mouth at Twodot													
90 %	0.6	0.3	0.2	0.1	0.1	0.3	2	15	16	3	0.9	0.5	3.2
80 %	0.9	0.9	0.6	0.3	0.3	0.7	5	21	29	5	1	1	5.5
50 %	7	10	8	6	7	8	14	40	55	11	3	5	14
20 %	15	14	11	8	9	12	25	62	98	23	7	10	24
AVG	8	9	7	5	6	7	15	43	62	15	4	6	16
Careless Creek below Little Careless Creek near Hedgesville													
90 %	0.5	0.4	0.5	0.4	0.4	0.2	1	10	6	2	1	0.7	1.9
80 %	0.6	0.6	0.6	0.5	0.6	0.6	3	12	7	2	1	1	2.5
50 %	0.8	0.7	0.8	0.8	1	4	5	13	13	3	2	1	3.8
20 %	2	1	1	1	2	20	13	20	24	5	2	2	8
AVG	1	1	1	0.8	1	13	9	15	15	3	2	1	5.2
Checkerboard Creek near Checkerboard													
90 %	1	0.7	0.7	0.7	0.6	0.6	1	13	10	3	2	1	2.9
80 %	1	1	0.9	0.8	0.8	0.8	2	16	12	4	2	2	3.6
50 %	2	1	1	1	1	1	4	20	23	6	3	2	5
20 %	3	2	2	2	1	1	9	31	36	11	4	3	9
AVG	2	2	1	1	1	1	6	22	25	7	3	2	6
Cottonwood Creek below Loco Creek near Martinsdale													
90 %	10	8	7	6	6	5	7	94	73	28	15	12	23
80 %	13	10	8	7	7	5	13	120	110	40	20	15	31
50 %	17	12	10	9	9	6	30	190	200	61	27	20	49
20 %	22	14	11	11	10	7	64	290	310	85	39	28	74
AVG	18	12	10	8	8	6	40	200	220	65	29	22	53
Flatwillow Creek below the forks near Grass Range													
90 %	3	2	2	3	2	3	8	87	90	12	4	3	18
80 %	3	4	3	3	3	4	11	100	120	17	5	4	23
50 %	4	4	5	6	5	6	21	120	200	43	8	6	36
20 %	15	14	11	9	4	7	49	170	300	89	16	10	58
AVG	10	10	8	7	4	8	33	130	220	51	10	7	42
Musselshell River at Harlowton													
90 %	19	35	37	31	36	53	45	64	87	48	22	13	41
80 %	45	54	47	43	46	62	71	130	150	67	36	35	66
50 %	71	76	67	56	65	87	130	300	460	140	84	65	133
20 %	110	110	91	74	97	150	240	630	770	210	130	100	226
AVG	76	81	72	61	70	110	170	390	510	170	83	70	155
Musselshell River near Mosby													
90 %	2	10	17	11	25	72	54	64	70	14	5	9	29
80 %	15	36	31	21	48	120	88	100	150	51	20	20	58
50 %	69	74	67	70	120	270	180	360	590	140	87	73	175
20 %	120	140	130	120	280	630	540	960	1800	500	220	180	468
AVG	82	87	82	86	220	550	350	630	1000	350	120	130	307
Musselshell River near Roundup													
90 %	12	15	16	24	24	50	38	93	130	94	32	40	47
80 %	25	33	25	34	37	80	55	120	200	120	70	48	71
50 %	68	64	57	52	93	140	110	310	520	220	180	110	160
20 %	110	120	110	110	160	290	320	700	1000	330	270	190	309
AVG	73	74	71	69	110	220	200	440	720	290	170	120	213

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
North Fork Musselshell River near Delpine													
90 %	4	5	5	4	4	5	7	10	10	6	3	4	6
80 %	5	6	5	4	5	6	11	16	14	8	4	4	7
50 %	6	7	6	6	6	8	17	24	27	13	9	8	11
20 %	9	9	7	7	7	12	27	40	41	23	13	11	17
AVG	7	7	6	6	6	9	19	26	29	15	9	8	12
North Fork Musselshell River near mouth near Martinsdale													
90 %	5	6	5	5	5	6	9	48	31	11	6	5	12
80 %	6	7	6	5	6	7	14	57	39	14	8	7	15
50 %	9	9	8	7	7	9	23	68	70	22	13	10	21
20 %	13	11	9	9	9	14	38	100	120	37	18	14	33
AVG	10	10	8	7	8	11	27	70	78	25	13	11	23
South Fork Musselshell River above Martinsdale													
90 %	11	13	11	8	11	14	43	100	94	19	6	5	28
80 %	18	18	14	11	14	17	54	170	140	28	12	10	42
50 %	30	28	21	17	20	29	99	310	290	66	21	21	79
20 %	40	35	27	23	26	53	160	430	510	120	44	36	125
AVG	31	28	22	18	21	37	110	320	340	78	27	25	88
Spring Creek below Whitetail Creek near Checkerboard													
90 %	3	3	2	2	2	2	5	28	21	8	5	4	7
80 %	4	3	3	2	3	2	8	35	30	11	6	5	9
50 %	6	4	3	3	3	3	16	78	58	20	10	7	18
20 %	8	5	4	4	4	5	27	130	93	29	14	9	28
AVG	6	5	4	3	3	4	18	87	68	21	10	7	20

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Swimming Woman Creek below Dry Coulee near Franklin													
90 %	0.5	0.3	0.4	0.4	0.3	0.2	0.5	10	7	2	1	0.7	1.9
80 %	0.6	0.5	0.5	0.4	0.4	0.3	1	12	9	3	1	1	2.5
50 %	0.9	0.5	0.6	0.6	0.5	0.5	3	14	17	4	2	1	3.7
20 %	2	1	0.8	0.8	0.6	0.5	6	21	27	8	2	2	6.0
AVG	1	0.9	0.7	0.6	0.5	0.6	4	15	19	5	2	2	4.3
FORT PECK RESERVOIR DRAINAGE													
Big Dry Creek above Little Dry Creek near Van Norman													
90 %	0	0	0	0	0	0.3	0.2	0.1	0.1	0	0	0	0.1
80 %	0	0	0	0	0	3	1	1	1	0.5	0	0	0.5
50 %	0.2	0.2	0.4	0	1	30	4	3	14	4	2	0.5	4.9
20 %	2	1.3	0.8	0.8	50	400	27	17	80	25	6	4	51.2
AVG	1	0.8	1	1	34	190	58	18	43	31	7	9	32.8
Big Dry Creek near Van Norman													
90 %	0.1	0.3	0	0	0	3	3	1	2	0.4	0.1	0	0.8
80 %	0.3	0.5	0.2	0	0	7	4	3	3	1	0.3	0.1	1.6
50 %	2	2	1	0.1	3	73	10	8	28	9	4	2	11.8
20 %	8	4	2	2	98	640	50	34	140	47	14	9	87
AVG	5	3	3	3	62	300	100	35	77	57	16	19	57
Little Dry Creek near Van Norman													
90 %	0.1	0.2	0	0	0	2	2	1	1	0.3	0.1	0	0.6
80 %	0.2	0.4	0.2	0	0	4	2	2	2	1	0.3	0.1	1.0
50 %	2	1	0.8	0.1	2	32	6	5	14	5	2	1	5.9
20 %	5	3	2	1	42	210	23	17	55	22	8	5	33
AVG	3	2	2	2	28	110	42	17	34	26	9	10	24

Source: USGS 1989

APPENDIX E

WATER QUALITY CLASSIFICATIONS AND IMPAIRMENTS FOR STREAMS WHERE RESERVATIONS ARE REQUESTED

Table E-1. Water quality classifications and impairments for streams where reservations are requested

Gallatin Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Baker Creek	B-1	Critical low flow
Ben Hart Spring Creek	B-1	None
Big Bear Creek	B-1	Critical low flow
Bridger Creek	B-1	Critical low flow
Cache Creek	B-1	Sediment
E Fork Hyalite Creek	A-1	None
E Gallatin River #1 below wastewater treatment plant	B-1	Sediment, nutrients, other
E Gallatin River #2 below wastewater treatment plant	B-1	Sediment, pH, nutrients, temperature
E Gallatin River #3	B-1	Sediment, pH, nutrients, temperature
Gallatin River #1	B-1	Critical low flow
Gallatin River #2	B-1	Critical low flow
Gallatin River #3	B-1	Critical low flow
Hell Raising Creek	A-1/B-1	None
Taylor Fork Gallatin River	B-1	Sediment
Middle Fork Hyalite Creek #1	A-1/B-1	Critical low flow
Middle Fork Hyalite Creek #2	B-1	Sediment, pH, nutrients
Middle Fork of West Fork Gallatin River	B-1	None
Porcupine Creek	B-1	None
Reese Creek	B-1	Nutrients
Rocky Creek	B-1	None
Sourdough Creek	B-1	Sediment, DO/BOD, pH, nutrients, critical low flow
S Fork Cottonwood Creek	B-1	Critical low flow
S Fork Spanish Creek	A-1/B-1	None
South Fork of West Fork Gallatin River	B-1	Sediment
Spanish Creek	B-1	None
Squaw Creek	B-1	None
Thompson Creek	B-1	Sediment
W Fork Hyalite Creek	A-1	None
West Fork of Gallatin River	B-1	Sediment

Madison Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Antelope Creek	B-1	None
Beaver Creek	A-1/B-1	Sediment
Black Sand Spring Creek	B-1	None
Blaine Spring Creek	B-1	Critical low flow
Cabin Creek	B-1	Sediment
Cherry Creek	B-1	None
Couger Creek	B-1	None
Duck Creek	B-1	None
Elk River	B-1	None
Grayling Creek	B-1	None
Hot Springs Creek	B-1	None
Indian Creek	A-1/B-1	Critical low flow
Jack Creek	B-1	Sediment, critical low flow
Madison River	B-1/A-1	Temperature, metals
Meadow Creek	B-1	Critical low flow
Moore Creek	B-1	Metals, critical low flow
O'Dell Spring Creek	B-1	None
Red Canyon Creek	B-1	None
Ruby Creek	B-1	Critical low flow
S Fork Madison River	B-1	Nonep
Squaw Creek	A-1/B-1	None
Standard Creek	B-1	None
Trapper Creek	B-1	None
Watkins Creek	B-1	Critical low flow
W Fork Madison River	B-1	Sediment

[a] Note: Stream/reach locations #1, #2, etc., are described in the DFWP application, June 1989.
[b] Source: DHES 1984,1986; DFWP 1985-1989

Jefferson and Boulder Drainages

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Boulder River	B-1	Sediment, pH, nutrients, temperature, metals, critical low flow
Halfway Creek	B-1	None
Hells Canyon Creek	B-1	Critical low flow
Jefferson River	B-1	Sediment, temperature, critical low flow
Little Boulder River	B-1	Critical low flow
N Willow Creek	B-1	Critical low flow
S Boulder River	B-1	pH, metals, critical low flow
S Willow Creek	B-1	None
Whitetail Creek	B-1	Critical low flow
Willow Creek	B-1	Critical low flow
Willow Springs Creek	B-1	Critical low flow

Big Hole and Ruby Drainages

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Alder Creek	B-1	Critical low flow
Big Hole River #1	A-1	Critical low flow
Big Hole River #2	A-1	Critical low flow
Big Hole River #3	B-1	Sediment, temperature, critical low flow
Big Lake Creek	A-1	Critical low flow
Canyon Creek	B-1	Critical low flow
Coal Creek	B-1	None
Cottonwood Creek	B-1	Sediment
Divide Creek	B-1	Critical low flow
E Fork Ruby River	B-1	Sediment, critical low flow
Fishtrap Creek	B-1	Critical low flow
Francis Creek	A-1	Critical low flow
Governor Creek	A-1	Sediment, critical low flow
Jerry Creek	B-1	Critical low flow
Johnson Creek	B-1	Critical low flow
M Fork Ruby River	B-1	Sediment
Mill Creek	B-1	Critical low flow
Miner Creek	A-1	Sediment
Moose Creek	B-1	Critical low flow
Mussigbrod Creek	B-1	Critical low flow
N Fork Big Hole River	B-1	Critical low flow
N Fork Greenhorn Creek	B-1	None
Pintlar Creek	B-1	Critical low flow
Rock Creek	A-1	Critical low flow
Rock Creek	B-1	Critical low flow
Ruby Creek	B-1	Critical low flow
Ruby River #1	B-1	Sediment
Ruby River #2	B-1	Sediment
S Fork Big Hole River	A-1	None
Steel Creek	A-1	Sediment
Steel Creek	B-1	Critical low flow
Swamp Creek	A-1	Sediment
Trapper Creek	B-1	Critical low flow
Warm Springs Creek	A-1	None
Warm Springs Creek	B-1	Sediment, temperature, critical low flow
W Fork Ruby River	B-1	Sediment
Willow Creek	B-1	Critical low flow
Wisconsin Creek	B-1	Critical low flow

[a] Note: Stream/reach locations #1, #2, etc., are described in the DFWP application, June 1989.
[b] Source: DHES 1984,1986; DFWP 1985-1989

Beaverhead and Red Rocks Drainages

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Bear Creek	B-1	None
Beaverhead River Reach #1 and #2	B-1	Sediment, nutrients, temperature, metals, critical low flow
Big Sheep Creek	B-1	Critical low flow
Black Canyon Creek	B-1	None
Blacktail Deer Creek	B-1	Sediment
Bloody Dick Creek	B-1	Sediment, critical low flow
Browns Canyon Creek	B-1	None
Cabin Creek	B-1	None
Corral Creek	A-1/B-1	None
Deadman Creek	B-1	Sediment
E Fork Blacktail Deer Creek	B-1	None
E Fork Clover Creek	B-1	None
E Fork Dyce Creek	B-1	None
Frying Pan Creek	B-1	pH, metals
Grasshopper Creek	B-1	Sediment, metals, critical low flow
Hell Roaring Creek	A-1/B-1	None
Horse Prairie Creek	B-1	Sediment, critical low flow
Indian Creek	B-1	None
Jones Creek	A-1/B-1	Sediment, critical low flow
Long Creek	B-1	Sediment
Medicine Lodge Creek	B-1	Sediment, critical low flow
Narrows Creek	B-1	None
Odell Creek	B-1/A-1	Sediment
Peet Creek	B-1	Critical low flow
Poindexter Slough	B-1	None
Rape Creek	B-1	None
Red Rock Creek	B-1/A-1	Sediment, temperature
Red Rock River #1	B-1	Critical low flow
Red Rock River #2	B-1	Critical low flow
Reservoir Creek	B-1	None
Shenon Creek	B-1	None
Simpson Creek	B-1	None
Tom Creek	B-1/A-1	Sediment
Trapper Creek	B-1	Sediment
W Fork Blacktail Deer Creek	B-1	Sediment, critical low flow
W Fork Dyce Creek	B-1	None

Missouri River - Holter Dam to Belt Creek

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Beaver Creek	B-1/A-1	Sediment
Canyon Creek	B-1	None
Cottonwood Creek	B-1	None
Little Prickly Pear	B-1	Sediment, critical low flow
Lyons Creek	B-1	None
McGuire Creek	B-1	None
Missouri River (Great Falls to Canyon Ferry)	B-1	Sediment, pH, nutrients, metals
Missouri River (Great Falls to Belt Creek)	B-3	Sediment, pH, TDS, nutrients, metals
Prickly Pear #1 (below East Helena)	B-1/I	Sediment, nutrients, metals, critical low flow
Prickly Pear #2 (above East Helena)	I	Sediment, nutrients, metals
Sevenmile Creek	B-1	None
Silver Creek	B-1	Metals
Spokane Creek	B-1	None
Tenmile Creek	A-1/B-1	Sediment, pH, temperature, metals, critical low flow
Trout Creek (above East Helena)	B-1	Natural
Virginia Creek	B-1	Sediment, metals
Willow Creek	A-1/B-1	None
Wolf Creek	B-1	None

Missouri River - Three Forks to Holter Dam

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Avalanche Creek	B-1	Critical low flow
Beaver Creek	B-1	Sediment
Confederate Gulch	B-1	Sediment, critical low flow
Crow Creek	B-1	Sediment, critical low flow
Deep Creek	B-1	Critical low flow
Dry Creek	B-1	Sediment, critical low flow
Duck Creek	B-1	Critical low flow
Missouri River #1 (above Canyon Ferry)	B-1	Sediment, pH, temperature, metals, critical low flow
Sixteen Mile Creek	B-1	Sediment, nutrients, critical low flow

[a] Note: Stream/reach locations #1, #2, etc., are described in the DFWP application, June 1989.
[b] Source: DHES 1984,1986; DFWP 1985-1989

Dearborn Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Bean Lake	B-1	DO/BOD, nutrients
Dearborn River	A-1/B-1	Sediment, temperature, critical low flow
Flat Creek	B-1	None
M Fork Dearborn River	B-1	Sediment, critical low flow
Sheep Creek	B-1	None
S Fork Dearborn River	B-1	Critical low flow

Smith River Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Big Birch Creek	B-1	Critical low flow
Eagle Creek	B-1	None
Hound Creek	B-1	Critical low flow
N Fork Deep Creek	B-1	None
N Fork Smith River	B-1	Sediment, critical low flow
Newlan Creek	B-1	Sediment
Rock Creek	B-1	None
Sheep Creek	B-1	Sediment, critical low flow
Smith River	B-1	Sediment, temperature, critical low flow
S Fork Smith River	B-1	Critical low flow
Tenderfoot Creek	B-1	None

Sun River Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Elk Creek	B-1	Temperature, critical low flow
Ford Creek	B-1	Nutrients
Muddy Creek	I	Sediment, TDS, nutrients, temperature
N Fork Willow Creek	B-1	None
Sun River #1 (above Muddy Creek)	B-1	Sediment, nutrients, critical low flow
Sun River #2 (below Muddy Creek)	B-1/B-3	Sediment, TDS, nutrients, temperature, critical low flow
Willow Creek	B-1	None

Belt Creek Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Belt Creek #1 (above Dry Fork)	B-1	Sediment, nutrients, temperature, metals, critical low flow
Belt Creek #2 (below Dry Fork)	B-2	Sediment, nutrients, temperature, metals, critical low flow
Big Otter Creek	B-1	Sediment
Dry Fork Belt Creek	B-1	Metals
Legging Creek	B-1	None
Pilgram Creek	B-1	None
Sand Coulee Creek	B-1	Sediment, metals
Tillinghast Creek	B-1	None

Marias River Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Badger Creek	B-1	Sediment
Birch Creek	B-1	Sediment, TDS, critical low flow
Cut Bank Creek	B-1/B-2	Sediment, TDS, nutrients, critical low flow
Dupuyer Creek	B-1	Critical low flow
Marias River #1 (above Dry Fork)	B-2	Sediment, TDS
Marias River #2 (below Tiber Reservoir)	B-1/B-2	Sediment, pH, TDS, temperature
Marias River #3 (below Pondera Coulee)	B-2	Sediment, pH, TDS, temperature
N Badger Creek	B-1	None
N Fork Dupuyer Creek	B-1	None
S Badger Creek	B-1	None
S Fork Dupuyer Creek	B-1	None
S Fork Two Medicine River	B-1	Sediment

[a] Note: Stream/reach locations #1, #2, etc., are described in the DFWP application, June 1989.
[b] Source: DHES 1984,1986; DFWP 1985-1989

Teton River Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Deep Creek	B-1	Critical low flow
McDonald Creek	B-1	None
N Fork Deep Creek	B-1	None
S Fork Deep Creek	B-1	None
Spring Creek	B-2	Critical low flow
Teton River	B-1/B-2	Sediment, TDS , critical low flow

Missouri River - Belt Creek to Fort Peck Reservoir

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Highwood Creek	B-1	None
Missouri River	B-3	Sediment, pH, TDS, nutrients
Shonkin Creek	B-1	None

Judith River Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Beaver Creek	B-1	Sediment, temperature
Big Spring Creek #1	B-1/B-2	Sediment, pH, nutrients
Big Spring Creek #2	B-2	Sediment, pH, nutrients
Cottonwood Creek	B-1	Sediment, temperature
Cow Creek	B-1	None
E Fork Big Spring Creek	B-1	Temperature
Judith River #1 (below Big Spring Creek)	B-2	None
Judith River #2 (above Big Spring Creek)	B-1	Critical low flow
Lost Fork Judith River	B-1	Sediment
Middle Fork Judith River	B-1	Sediment
Running Wolf Creek	B-1	TDS
S Fork Judith River	B-1	Sediment
Warm Springs Creek	C-3	Sediment
Yogo Creek	B-1	Sediment

Musselshell Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Alabaugh Creek	B-1	None
American Fork Creek	B-1	Critical low flow
Big Dry Creek	C-3	None
Big Elk Creek	B-1	Critical low flow
Careless Creek	B-1	Temperature, critical low flow
Checkerboard Creek	B-1	None
Collar Gulch Creek	C-3	pH, metals
Cottonwood Creek	B-1	Critical low flow
Flatwillow Creek	B-2/C-3	pH, metals, sediment, critical low flow
Little Dry Creek	C-3	None
Musselshell River #1 (N&S Forks to Deadmans Diversion)	B-1/B-2	Sediment, DO/BOD, TDS, nutrients, temperature, critical low flow
Musselshell River #2 (below Deadmans Diversion)	C-3	Sediment, DO/BOD, pH, TDS, nutrients, temperature, critical low flow
Musselshell River #3 (Diversion area)	C-3	Sediment, DO/BOD, pH, TDS, nutrients, temperature, critical low flow
N Fork Musselshell River #1	B-1	Critical low flow
N Fork Musselshell River #2 (below Bair Reservoir)	B-1	Sediment, DO/BOD, TDS, nutrients, temperature
S Fork Musselshell River	B-1	Sediment, critical low flow
Spring Creek	B-1	Sediment, critical low flow
Swimming Woman Creek	B-1	Critical low flow

[a] Note: Stream/reach locations #1, #2, etc., are described in the DFWP application, June 1989.
[b] Source: DHES 1984,1986; DFWP 1985-1989

Table E-2. Water quality data for abandoned coal mines near Roundup

Mine	Date	Specific Conductance	pH	Dissolved Solids[a] mg/l	Calcium mg/l	Magnesium mg/l	Sodium[b] mg/l	Potassium mg/l	Bicarbonate mg/l	Sulfate mg/l	Chloride mg/l	Sodium Adsorption Ratio	Arsenic mg/l	Iron mg/l	Zinc mg/l
Jeffrey (R-144)	7/29/86	1,890	7.7	1,280	86	43	298	4	464	589	27	6.6	—	—	—
Jeffrey (R-145)	7/30/86	1,930	7.6	1,320	88	44	301	4	465	624	29	7.4	—	—	—
Jeffrey (R-145)	7/14/89	1,800	7.8	1,325	76	38	332	5	463	615	28	7.8	<.005	.81	.01
Jeffrey (R-146)	12/18/86	1,880	7.6	1,290	86	42	301	6	471	592	27	6.7	—	—	—
Jeffrey (R-145)	12/22/89	1,984	8.1	1,320	85	44	304	5	446	620	28	6.7	.001	.24	<.007
Republic #1	12/16/13	—	—	793	99	41	110**	—	334	359	15	2.4	—	—	—
Republic #1	4/ 1/59	—	—	1,200	120	80	170**	—	323	669	12	2.9	—	—	—
Republic	3/19/75	1,730	7.5	1,150	112	70	175	4	349	600	23	3.3	—	—	—
Republic #1	7/14/86	—	7.2	2,530	212	117	455	6	538	1,436	24	6.2	—	—	—
Republic #1	1/ 5/89	3,000	7.8	2,535	204	121	483		538	1,462	—	6.6	<.001	1.15	—
Roundup #3 West	3/12/81	2,200	7.5	1,590	63	39	414	8	483	809	20	10.0	—	—	—
Roundup #3 West (R-036)	5/30/90	3,530	7.1	2,761	168	148	525	18	549	1,580	32	8.1	—	—	—
Roundup #3 East	7/30/56	2,010	8.0	1,340	87	46	293	5	347	715	21	6.3	—	—	—
Roundup #3 East (R-153)	7/10/89	6,430	7.0	5,155	393	277	857	15	1,150	3,010	23	8.1	—	2.34	.02
Roundup #3 East (R-068)	5/24/90	5,530	8.1	4,270	37	155	1,230	18	1,350	2,130	35	24.4	—	1.62	1.64
Prescott (R-154)	7/10/89	6,260	6.9	5,090	472	204	891	14	953	3,000	27	8.6	—	1.81	.23
Republic #2	1/22/10	—	—	883	37	36	220**	—	415	339	16	6.2	—	—	—
Republic #2 (R-151)	7/12/89	4,550	7.0	4,055	327	145	792	12	926	2,300	15	9.2	—	1.15	.11
Republic #2 (R-151)	5/23/90	4,950	7.4	4,010	323	145	827	12	957	2,210	21	10.5	—	1.13	.09
Republic #2 (R-150)	5/23/90	5,720	7.5	4,768	313	196	999	14	952	2,730	28	12.2	—	11.9	.43
Republic #4 (R-160)	7/31/89	2,780	7.2	2,140	111	72	541	7	717	1,030	25	9.8	—	.26	.06

[a] All individual constituents are dissolved values.
[b] Sodium concentrations derived from sodium adsorption ratio, calcium, and magnesium values
Sources: Wheaton and VanVoast 1989 and Wheaton 1990

Table E-3. Selected water quality data for Musselshell River at Roundup

Discharge (cfs)	Date	Specific Conductance	pH	Dissolved Solids[a] mg/l	Calcium mg/l	Magnesium mg/l	Sodium[b] mg/l	Potassium mg/l	Bicarbonate mg/l	Sulfate mg/l	Chloride mg/l	Sodium Adsorption Ratio	Arsenic mg/l	Iron mg/l	Zinc mg/l
26.1	10/18/77	2,180	8.2	1,612	120	100	260	5.1	340	930	23	4.2	.004	.020	<.02
58.0	2/16/78	1,850	7.9	1,226	130	94	120	3.9	320	690	21	2.0	—	<.010	—
906.0	7/13/78	970	8.4	718	83	46	88	3.3	270	340	10	1.9	.002	.030	<.02
107.0	1/ 9/79	1,750	7.8	1,128	79	80	170	4.7	—	630	22	3.2	—	.030	—
3,390.0	3/11/79	796	8.0	532	51	26	83	6.6	—	280	13	2.4	.001	.030	.02
4,470.0	6/23/79	678	7.9	545	57	26	150	7.7	—	190	6.7	4.1	.002	.170	.03
98.0	10/18/79	1,710	8.4	1,282	110	81	190	5.9	—	710	23	3.4	—	.030	—
57.0	1/10/80	1.970	8.1	1,383	130	83	190	4.7	—	730	21	3.2	—	.030	—
1,400.0	6/17/80	960	8.4	616	63	33	95	3.8	—	290	7	2.4	—	.040	—
124.0	9/10/80	1,360	8.4	962	82	57	140	5.2	—	520	13	2.9	.002	<.020	.003
39.0	12/10/80	2,240	8.1	1,560	140	96	250	7.2	—	870	22	4.0	—	.030	—
3,920.0	5/19/81	920	8.1	676	57	35	100	5.6	—	320	10	2.6	.003	.140	.020
326.0	7/15/81	1,320	--	935	83	59	130	3.8	—	500	14	2.7	—	<.010	—
60.0	9/23/81	1,600	8.4	1,134	91	71	170	4.2	—	630	18	3.2	—	.017	—

[a] All individual constituents are dissolved values
[b] Sodium concentrations derived from sodium adsorption ratio, calcium, and magnesium values
Source: U.S. Geological Survey Data Files

APPENDIX F

SOILS LIST FOR WATER RESERVATION IRRIGATION PROJECTS

Table F-1. Soils list for water reservation irrigation projects

Amesha loam
Amsterdam silt loam
Anaconda cobbly loam
Attewan loam
Beaverell cobbly loam
Beaverell loam
Beaverton silt loam
Binna loam
Bozeman silt loam
Bridger loam
Brocko silt loam
Brownsto gravelly loam
Burgraff silt loam
Cabba loam
Chinook fine sandy loam
Cozberg fine sandy loam
Danvers clay loam
Delpoint loam
Doughty loam
Ethridge silt clay loam
Evanston cobbly clay loam
Evanston loam
Fairdale silt loam
Fairway loam
Famuf loam
Fort Benton fine sandy loam
Gallatin loam
Gerber silty clay loam
Glendive loam
Glendive sandy loam
Hagga silt loam
Harlem silty clay loam
Havre loam
Huffine silt loam
Joplin clay loam
Judith clay loam
Judith gravelly clay loam
Kalstad sandy loam
Kevin clay loam
Kiev loam
Kobar silty clay
Kobar silty clay loam
Korchea loam
Korent loam
Kremlin clay loam
Kremlin loam
Lothair silty clay
Marias silty clay
Marmarth loam
Martinsdale clay loam
Martinsdale loam
Mussel loam
Musselshell gravelly loam
Neen silty clay loam
Pendroy clay
Perma very stony loam
Phillips clay loam
Radersburg very cobbly loam
Rivra gravelly sandy loam
Rothiemay clay loam
Rothiemay loam
Ryell loam
Sappington loam
Scobey clay loam
Scravo sandy loam
Scravo cobbly loam
Shaak silty clay loam
Straw loam
Tally fine sandy loam
Tamaneen clay loam
Tanna clay loam
Telstad loam
Terrad silty clay
Tetonview loam
Toston silty clay loam
Tumer cobbly loam
Tumer loam
Twin Creek loam
Varney gravelly clay loam
Vastine loam
Windham very gravelly loam
Winifred cobbly clay loam
Winspect cobbly loam
Work cobbly clay loam
Yamac loam

APPENDIX G

FISHERIES DATA

Table G-1. Fisheries value class and relative fish abundance by stream

Key to Symbols: 1=outstanding 2=high-value 3=substantial 4=moderate 5=limited 6=insufficient information to classify stream

A=Abundant; C=Common; P=Present; PE=Presence expected but not confirmed; U=Uncommon; R=Rare

Headwaters subbasin

	FAMILY	Sturgeon		Paddlefish	Mooneye	Trout								Pike	Minnow																	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
	COMMON NAME	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
Stream	Fisheries Resource Value Class																																																								
GALLATIN RIVER DRAINAGE																																																									
Baker Creek																																																									
I-90-Mouth	2					U				C	C																										P	P																			P	
County Road-I-90	4					U				C	C																										P																				P	
Ben Hart Spring Creek	6					P				P	P	P																																													
Big Bear Creek	6							P				P																																												P	
Bridger Creek	4					U		U		C	U	U																									P																				C	
Cache Creek	4							C		U																																															
EF of Hyalite Creek	2							C				U	C																																											C	
East Gallatin River #1	2					C		P		C	C	U																										C																			A	
East Gallatin River #2	2					U				A	A	U																				A						A	A		A																	C	
East Gallatin River #3																																																									
Smith Creek-Mouth	3					C				U	A	U																				PE						A	A		C																	C	
Hyalite Creek-Smith Creek	3					C				C	A	U																				PE						A	A		A																	C	
Gallatin River #1	2					A		R		C	C	U																				U						C	C		U																	C	
Gallatin River #2																																																									
Baker Creek-East Gallatin River	2					A				C	C	U																				U						C	C		U																	C	
Cameron Bridge-Baker Creek	3					C				U	C	U																				U						C	C		U																	C	
Gallatin Gateway-Cameron Bridge	2					A				U	C	U																				U						C	C		U																	C	
Spanish Creek-Gallatin Gateway	1					A		R		C	C	U																				U						C	C		U																	C	
W. Fk. Gallatin River-Spanish Creek	1					A		R		C	U	U																				U						C	C		U																	C	
Gallatin River #3	2					A				C	A	U																				P						C	C		P																	A	
Hell Roaring Creek	6									P																																															P	
Hyalite Creek #1																																																									
Hyalite Reservoir-National Forest	4					U		U		U	C	U																				U						U																				U	
National Forest-County Road	3							C		A		U																				U						PE																				C	
Hyalite Creek #2	4					U				U	U	P																				U						U	P		P																	U	
MF of the WF Gallatin River	4							U		C		P																																															
Porcupine Creek	4					U		U		C	U																																														A	
Reese Creek	2									C	A	C																																													P	
Rocky Creek	2					U				C	C	U																				C						C	C		P																	C	
Sourdough (Bozeman) Creek																																																									
National Forest-Mouth	3									C	U	C																										U																				C	
Mystic Lake-National Forest	3									C		C																																														C	
South Cottonwood Creek	6									P	P	P																																														P	
SF of Spanish Creek																																																									
Falls Creek-National Forest	4									U		C																																														PE	
National Forest-Mouth	4									C	P	C																																														PE	
SF of the WF Gallatin River	4							C		C																																																C	
Spanish Creek	1					P				C	P	C																																														P	
Squaw Creek	1									C	U	C																																														C	
Taylor Fork of the Gal. River																																																									
Source-Lightening Creek	3							C		C																																																P	
Lightening Creek-Mouth	3					C		C		C	U																																														C	
Thompson Spring Creek																																																									
East/West County Road-Mouth	4					P				C	C	U																				U																										C	
Headwaters-East/West County Road	3									C	C	U																				U																										C	
WF of the Gallatin River	1					U		U		A	U																																															P	
WF of Hyalite Creek	2							C				U	C																			PE						PE																				C	

Headwaters subbasin (continued)

Key to Symbols: 1=outstanding; 2=high value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

Stream	Fisheries Resource Value Class	Sturgeon: Pallid sturgeon	Sturgeon: Shovelnose sturgeon	Paddlefish: Paddlefish	Mooneye: Goldeye	Trout: Mountain whitefish	Trout: Kokanee	Trout: Cutthroat trout	Trout: Rainbow/cutthroat hybrid	Trout: Rainbow trout	Trout: Brown trout	Trout: Brook trout	Trout: Arctic grayling	Pike: Northern pike
MADISON RIVER DRAINAGE														
Antelope Creek	2									A				
Beaver Creek	4					C				U	U			
Black Sand Spring Creek	2							U		C	C	P		
Blaine Spring Creek	2									C	C			
Cabin Creek														
6mi. Above Mouth-0.5mi. Above Mouth	4							P		P				
Cub Creek-Mouth -	4					U				U	U			
Cherry Creek	4					P				C	U	P		
Cougar Creek	3					A				U	A	U		
Duck Creek	3					A		P		U	A	U		
Elk River	4							P	P	U	C			
Grayling Creek	6					P		P	P	P	P	P		
Hot Springs Creek	4					PE				C	C	P		
Indian Creek	4							U		C	P			
Jack Creek	3					U				C	C			
Madison River #1	1					A		U		A	A	U		
Madison River #2														
Sheep Creek-Varney Bridge	1					A		U		A	A	U		
Hebgen Lake-Sheep Creek	1					A				A	A			
Madison River #3	1					A				A	A	U	U	
Madison River #4														
Greycliff Access-Mouth	1					A		P		A	A	P	P	
Ennis Lake-Greycliff Access	1					A				A	A			
Moore Creek														
Source-Hwy. 287 in Ennis	4									U	U			
Hwy. 287 in Ennis-Mouth	2									A			A	
North Meadow Creek														
Sureshot Lakes Fork-National Forest	3							U		U		C		
National Forest-Mouth	3					C		U		C	C	U	U	
O'Dell Spring Creek	6					P				P	P	P		
Red Canyon Creek	6							P		P				
Ruby Creek	3							U		C	U			
SF of the Madison River														
Headwaters-Railroad Line	3									U	C	U		
Railroad Line-Mouth	2					A				U	A	U		
Squaw Creek	4							C		U	P	U		
Standard Creek	4							U	P	U	P		P	
Trapper Creek	6							P		P				
Watkins Creek	6							P		P				
WF of the Madison River														
Meridian Creek-Soap Creek	3							U		U	U	C		
Soap Creek-Mouth	3					U				U	C	U		
Whiskey Spring	6										P	P		
JEFFERSON RIVER DRAINAGE														
Boulder River #1														
Basin-Boulder	4					U				C		U		
Headwaters-Basin	4					C		PE		C		C		
Boulder River #2	4					U				U	C	U		

Stream	Minnow: Carp	Minnow: Minnow	Minnow: N. Redbelly x finescale dace	Minnow: Utah chub	Minnow: Flathead chub	Minnow: Sturgeon chub	Minnow: Lake chub	Minnow: Sicklefin chub	Minnow: Emerald shiner	Minnow: Redside shiner	Minnow: Sand shiner	Minnow: Brassy minnow	Minnow: Plains minnow	Minnow: Plains/silvery minnow	Minnow: Silvery minnow	Minnow: Fathead minnow	Minnow: Longnose dace
MADISON RIVER DRAINAGE																	
Antelope Creek																	
Beaver Creek																	
Black Sand Spring Creek																	
Blaine Spring Creek																	
Cabin Creek																	
6mi. Above Mouth-0.5mi. Above Mouth																	
Cub Creek-Mouth -																	
Cherry Creek																	
Cougar Creek																	
Duck Creek																	
Elk River																	
Grayling Creek																	
Hot Springs Creek																	P
Indian Creek																	
Jack Creek																	P
Madison River #1				A													PE
Madison River #2																	
Sheep Creek-Varney Bridge																	A
Hebgen Lake-Sheep Creek				A													A
Madison River #3				A													A
Madison River #4																	
Greycliff Access-Mouth	C			U													A
Ennis Lake-Greycliff Access																	A
Moore Creek																	
Source-Hwy. 287 in Ennis																	
Hwy. 287 in Ennis-Mouth																	
North Meadow Creek																	
Sureshot Lakes Fork-National Forest																	
National Forest-Mouth																	
O'Dell Spring Creek																	
Red Canyon Creek																	
Ruby Creek																	
SF of the Madison River																	
Headwaters-Railroad Line																	
Railroad Line-Mouth																	
Squaw Creek																	
Standard Creek																	
Trapper Creek																	
Watkins Creek																	
WF of the Madison River																	
Meridian Creek-Soap Creek																	
Soap Creek-Mouth																	
Whiskey Spring																	
JEFFERSON RIVER DRAINAGE																	
Boulder River #1																	
Basin-Boulder																	U
Headwaters-Basin																	U
Boulder River #2																	U

Stream	Sucker: River carpsucker	Sucker: Blue sucker	Sucker: Smallmouth buffalo	Sucker: Bigmouth buffalo	Sucker: Shorthead redhorse	Sucker: Longnose sucker	Sucker: White sucker	Sucker: Largescale sucker	Sucker: Mountain sucker	Catfish: Black bullhead	Catfish: Channel catfish	Catfish: Stonecat	Codfish: Burbot
MADISON RIVER DRAINAGE													
Antelope Creek							P						
Beaver Creek													
Black Sand Spring Creek													
Blaine Spring Creek						U							
Cabin Creek													
6mi. Above Mouth-0.5mi. Above Mouth													
Cub Creek-Mouth -						P							
Cherry Creek													
Cougar Creek													
Duck Creek													
Elk River													
Grayling Creek													
Hot Springs Creek						P			P				
Indian Creek													
Jack Creek													
Madison River #1													
Madison River #2													
Sheep Creek-Varney Bridge													
Hebgen Lake-Sheep Creek													
Madison River #3							P		P				
Madison River #4													
Greycliff Access-Mouth						A	A		A			A	
Ennis Lake-Greycliff Access						A	A		A			U	
Moore Creek													
Source-Hwy. 287 in Ennis						P							
Hwy. 287 in Ennis-Mouth													
North Meadow Creek													
Sureshot Lakes Fork-National Forest													
National Forest-Mouth													
O'Dell Spring Creek													
Red Canyon Creek													
Ruby Creek													
SF of the Madison River													
Headwaters-Railroad Line													
Railroad Line-Mouth													
Squaw Creek													
Standard Creek													
Trapper Creek													
Watkins Creek													
WF of the Madison River													
Meridian Creek-Soap Creek													
Soap Creek-Mouth													
Whiskey Spring													
JEFFERSON RIVER DRAINAGE													
Boulder River #1													
Basin-Boulder						U	U						
Headwaters-Basin						U	U						
Boulder River #2						U	U						

Stream	Sunfish: Green sunfish	Sunfish: Pumpkinseed	Sunfish: Bluegill	Sunfish: Smallmouth bass	Sunfish: Largemouth bass	Sunfish: White crappie	Sunfish: Black crappie	Perch: Yellow perch	Perch: Sauger	Perch: Walleye	Perch: Iowa darter	Drum: Freshwater drum	Sculpin: Mottled sculpin	Stickleback: Brook stickleback
MADISON RIVER DRAINAGE														
Antelope Creek													P	
Beaver Creek													C	
Black Sand Spring Creek														
Blaine Spring Creek													C	
Cabin Creek														
6mi. Above Mouth-0.5mi. Above Mouth														
Cub Creek-Mouth -													C	
Cherry Creek													C	
Cougar Creek													U	
Duck Creek													U	
Elk River													C	
Grayling Creek													P	
Hot Springs Creek													C	
Indian Creek													C	
Jack Creek													C	
Madison River #1													A	
Madison River #2														
Sheep Creek-Varney Bridge													A	
Hebgen Lake-Sheep Creek													A	
Madison River #3													A	
Madison River #4														
Greycliff Access-Mouth								U					A	
Ennis Lake-Greycliff Access													A	
Moore Creek														
Source-Hwy. 287 in Ennis													P	
Hwy. 287 in Ennis-Mouth														
North Meadow Creek														
Sureshot Lakes Fork-National Forest													C	
National Forest-Mouth													C	
O'Dell Spring Creek														
Red Canyon Creek														
Ruby Creek													C	
SF of the Madison River														
Headwaters-Railroad Line													C	
Railroad Line-Mouth													C	
Squaw Creek													C	
Standard Creek													C	
Trapper Creek														
Watkins Creek													P	
WF of the Madison River														
Meridian Creek-Soap Creek													C	
Soap Creek-Mouth													C	
Whiskey Spring														
JEFFERSON RIVER DRAINAGE														
Boulder River #1														
Basin-Boulder													C	
Headwaters-Basin													A	
Boulder River #2													U	

Headwaters subbasin (continued)

Key to Symbols: 1=outstanding; 2=high value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

Stream	Fisheries Resource Value Class	Sturgeon: Pallid sturgeon	Sturgeon: Shovelnose sturgeon	Paddlefish: Paddlefish	Mooneye: Goldeye	Trout: Mountain whitefish	Trout: Kokanee	Trout: Cutthroat trout	Trout: Rainbow/cutthroat hybrid	Trout: Rainbow trout	Trout: Brown trout	Trout: Brook trout	Trout: Arctic grayling	Pike: Northern pike
Boulder River #3	3					U				U	A	U		
Halfway Creek														
Headwaters-Halfway Park	1							A						
Finn Cabins-Mouth	4							PE				C		
Hells Canyon Creek														
Source-National Forest	4								A	P	C	U		
National Forest-Mouth	2								A		C			
Jefferson River														
Headwaters-Fish Creek	2					A				C	A			
Fish Creek-Big Pipestone Creek	2					A				C	A			
Big Pipestone Creek-Mouth	2					A				C	A	R		
Little Boulder River														
Headwaters-National Forest	4							U		C		C		
National Forest-Mouth	4					U				C	C	C		
North Willow Creek	3					R	U			C	C	R		
South Boulder River														
Headwaters-National Forest	3									U		A		
National Forest-Hwy 359 Bridge	3									C		C		
Hwy 359 Bridge-Mouth	4					U				U	U	U		
South Willow Creek	3					R	U			C	C	R		
Whitetail Creek														
Whitetail Reservoir-N. Boundary Sec. 4	6											P		
N. Boundary Sec. 4-SE Corner Sec. 36	4							PE			C	U		
SE Corner Sec. 36-Mouth	4										C	U		
Willow Creek														
N & S Willow Creek-Willow Creek Reservoir	3						U			C	U	C		
Willow Creek Dam-Mouth	3					C				U	C	R		
Willow Spring Creek	2									P	U	C		
BIG HOLE RIVER DRAINAGE														
American Creek	6								P	P		P		
Bear Creek	3								U			A		
Big Hole River, #1	1					C		R		U	C	U	R	
Big Hole River, #2	1													
Wise River-Divide	1					A		U		U	C	C	U	
Pintlar Creek-Wise River	1					A		R		C	U	R	R	
Big Hole River, #3	1					A		R		R	R	C	U	
Big Lake Creek	1					C						A	R	
Birch Creek	4													
Beaverhead/Willow Creek Ditch-Mouth	4									C		P		
Headwaters-Beaverhead/Willow Creek Ditch	4							U		R		C		
Bryant Creek	6											P		
California Creek	6					P				P		P		
Camp Creek	4							C	U	U	PE	C		
Canyon Creek	3							R	A	R	PE	C		
Corral Creek	3									R		A		
Deep Creek	3													
French Creek-Mouth	3					U				C		U	P	
Headwaters-French Creek	3					U		P		U		A		

Stream	Fisheries Resource Value Class	Minnow: Carp	Minnow: Minnow	Minnow: N. Redbelly x finescale dace	Minnow: Utah chub	Minnow: Flathead chub	Minnow: Sturgeon chub	Minnow: Lake chub	Minnow: Sicklefin chub	Minnow: Emerald shiner	Minnow: Redside shiner	Minnow: Sand shiner	Minnow: Brassy minnow	Minnow: Plains minnow	Minnow: Plains/silvery minnow	Minnow: Silvery minnow	Minnow: Fathead minnow	Minnow: Longnose dace
Boulder River #3	3																	U
Halfway Creek																		
Headwaters-Halfway Park	1																	
Finn Cabins-Mouth	4																	
Hells Canyon Creek																		
Source-National Forest	4																	
National Forest-Mouth	2																	
Jefferson River																		
Headwaters-Fish Creek	2	PE																PE
Fish Creek-Big Pipestone Creek	2	PE																PE
Big Pipestone Creek-Mouth	2	C				U					PE							U
Little Boulder River																		
Headwaters-National Forest	4																	
National Forest-Mouth	4																	C
North Willow Creek	3																	C
South Boulder River																		
Headwaters-National Forest	3																	
National Forest-Hwy 359 Bridge	3																	
Hwy 359 Bridge-Mouth	4																	
South Willow Creek	3																	C
Whitetail Creek																		
Whitetail Reservoir-N. Boundary Sec. 4	6																	
N. Boundary Sec. 4-SE Corner Sec. 36	4																	
SE Corner Sec. 36-Mouth	4																	
Willow Creek																		
N & S Willow Creek-Willow Creek Reservoir	3																	
Willow Creek Dam-Mouth	3																	U
Willow Spring Creek	2																	
BIG HOLE RIVER DRAINAGE																		
American Creek	6																	
Bear Creek	3																	
Big Hole River, #1	1	U																U
Big Hole River, #2	1																	
Wise River-Divide	1																	U
Pintlar Creek-Wise River	1																	U
Big Hole River, #3	1																	C
Big Lake Creek	1																	A
Birch Creek	4																	
Beaverhead/Willow Creek Ditch-Mouth	4																	
Headwaters-Beaverhead/Willow Creek Ditch	4																	
Bryant Creek	6																	
California Creek	6																	P
Camp Creek	4																	
Canyon Creek	3																	
Corral Creek	3																	
Deep Creek	3																	
French Creek-Mouth	3																	A
Headwaters-French Creek	3																	A

Stream	Fisheries Resource Value Class	Sucker: River carpsucker	Sucker: Blue sucker	Sucker: Smallmouth buffalo	Sucker: Bigmouth buffalo	Sucker: Shorthead redhorse	Sucker: Longnose sucker	Sucker: White sucker	Sucker: Largescale sucker	Sucker: Mountain sucker	Catfish: Black bullhead	Catfish: Channel catfish	Catfish: Stonecat	Codfish: Burbot
Boulder River #3	3						U	U						
Halfway Creek														
Headwaters-Halfway Park	1													
Finn Cabins-Mouth	4													
Hells Canyon Creek														
Source-National Forest	4													
National Forest-Mouth	2							U						
Jefferson River														
Headwaters-Fish Creek	2						PE	PE						
Fish Creek-Big Pipestone Creek	2						PE	PE						
Big Pipestone Creek-Mouth	2						A	A		U			R	
Little Boulder River														
Headwaters-National Forest	4													
National Forest-Mouth	4						U	U						
North Willow Creek	3						C	C						
South Boulder River														
Headwaters-National Forest	3													
National Forest-Hwy 359 Bridge	3													
Hwy 359 Bridge-Mouth	4													
South Willow Creek	3						C	C						
Whitetail Creek														
Whitetail Reservoir-N. Boundary Sec. 4	6													
N. Boundary Sec. 4-SE Corner Sec. 36	4													
SE Corner Sec. 36-Mouth	4													
Willow Creek														
N & S Willow Creek-Willow Creek Reservoir	3						C	C						
Willow Creek Dam-Mouth	3						U	C		R				
Willow Spring Creek	2													
BIG HOLE RIVER DRAINAGE														
American Creek	6													
Bear Creek	3													
Big Hole River, #1	1						C	C		U				U
Big Hole River, #2	1													
Wise River-Divide	1						C	C		U				U
Pintlar Creek-Wise River	1						C	C		U				C
Big Hole River, #3	1						C	U		U				C
Big Lake Creek	1						C							PE
Birch Creek	4													
Beaverhead/Willow Creek Ditch-Mouth	4													
Headwaters-Beaverhead/Willow Creek Ditch	4													
Bryant Creek	6													
California Creek	6						P							
Camp Creek	4													
Canyon Creek	3													
Corral Creek	3													
Deep Creek	3													
French Creek-Mouth	3						U							U
Headwaters-French Creek	3						C			A				U

Stream	Fisheries Resource Value Class	Sunfish: Green sunfish	Sunfish: Pumpkinseed	Sunfish: Bluegill	Sunfish: Smallmouth bass	Sunfish: Largemouth bass	Sunfish: White crappie	Sunfish: Black crappie	Perch: Yellow perch	Perch: Sauger	Perch: Walleye	Perch: Iowa darter	Drum: Freshwater drum	Sculpin: Mottled sculpin	Stickleback: Brook stickleback
Boulder River #3	3													U	
Halfway Creek															
Headwaters-Halfway Park	1														
Finn Cabins-Mouth	4														
Hells Canyon Creek															
Source-National Forest	4													C	
National Forest-Mouth	2													C	
Jefferson River															
Headwaters-Fish Creek	2													PE	
Fish Creek-Big Pipestone Creek	2													PE	
Big Pipestone Creek-Mouth	2					R		R	R					U	
Little Boulder River															
Headwaters-National Forest	4													A	
National Forest-Mouth	4													A	
North Willow Creek	3													C	
South Boulder River															
Headwaters-National Forest	3													C	
National Forest-Hwy 359 Bridge	3													C	
Hwy 359 Bridge-Mouth	4													C	
South Willow Creek	3													C	
Whitetail Creek															
Whitetail Reservoir-N. Boundary Sec. 4	6														
N. Boundary Sec. 4-SE Corner Sec. 36	4														
SE Corner Sec. 36-Mouth	4														
Willow Creek															
N & S Willow Creek-Willow Creek Reservoir	3													C	
Willow Creek Dam-Mouth	3													C	
Willow Spring Creek	2														
BIG HOLE RIVER DRAINAGE															
American Creek	6													P	
Bear Creek	3													U	
Big Hole River, #1	1													C	
Big Hole River, #2	1														
Wise River-Divide	1													C	
Pintlar Creek-Wise River	1													C	
Big Hole River, #3	1													C	
Big Lake Creek	1													PE	
Birch Creek	4														
Beaverhead/Willow Creek Ditch-Mouth	4													P	
Headwaters-Beaverhead/Willow Creek Ditch	4													A	
Bryant Creek	6														
California Creek	6													P	
Camp Creek	4													U	
Canyon Creek	3													A	
Corral Creek	3													P	
Deep Creek	3														
French Creek-Mouth	3													C	
Headwaters-French Creek	3													A	

Headwaters subbasin (continued)

Key to Symbols: 1=outstanding 2=high value 3=substantial 4=moderate 5=limited 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

	FAMILY	Sturgeon		Paddlefish	Mooneye	Trout								Pike	Minnow																	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
	COMMON NAME	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
Stream	Fisheries Resource Value Class																																																									
Delano Creek	6							P																																																		
Divide Creek	3									C	PE	A																									C																				A	
Fishtrap Creek	3																																																									
E Fk Fishtrap Creek-Mouth	3									U		A	P																		C						C							C													C	
W & M Fk Fishtrap Creek-E Fk Fishtrap Creek	5							PE				PE																																													PE	
Francis Creek	2					U						A	R																								A	R						C													A	
French Creek	4					U				P		U																			A						C							R													A	
Governor Creek	1					C				R		C	U																		A						R							U													A	
Jacobsen Creek	6					P			P			P																																														
Jerry Creek	4							PE	U	C		C																																													PE	
Johnson Creek	3					R						A	R																		A						U							C													A	
Joseph Creek	3											A																																C													A	
LaMarche Creek	3																																																									
National Forest boundary-Mouth	3							PE		U		A	U																								U							R													A	
W Fk LaMarche Creek-National Forest	3							PE		U		A	U																								U							R													A	
Miner Creek	1																																																									
National Forest-Mouth	1											A	U																															PE													PE	
Ridge Lakes Fk-National Forest	1							PE		P		A	U																								P							C													C	
Moose Creek	3							A	R	U		A																																													A	
Mussigbrod Creek	2											A	R																								R							R													A	
NF Big Hole River	1					C				P		A	U																		A						C							C													A	
Oregon Creek	6									P		P																																													P	
Pattengail Creek	3							P	P	U		C																																													A	
Pintlar Creek	3																																																									
National Forest-Mouth	3							R				C	R																								C							C													C	
Headwaters-National Forest	4							C				C																																													PE	
Rock Creek	1					C		PE				A	U																								C							C													C	
Ruby Creek	3							PE	P	R		A																									R							R													A	
Sevenmile Creek	6								P	P		P																									P																				P	
Seymour Creek	3											C																																														
Sixmile Creek	6							P	P	P		P																																													P	
SF Big Hole River	6					P				P		P																									P							P													P	
Steel Creek	1					U			C			A	U																		C						U							R													A	
Sullivan Creek	6											P																																													P	
Swamp Creek	1					R		PE				C	U																		C						C							C													A	
Tenmile creek	6									P		P																																P													P	
Trail Creek	3					C		PE				C																			C						C																				A	
Trapper Creek																																																										
National Forest-Mouth	4									PE	PE	U																																														
Sappington Creek-National Forest	4							C	C	U	R	A																																													A	
Twelvemile Creek	6								P			P																																													P	
Warm Springs Creek																																																										
National Forest-Mouth	3											A	PE																		C						R							U													A	
Little Milk Creek-National Forest	3							PE				A	PE																															PE													PE	
Willow Creek	3								C	P		A																																													A	
Wise River																																																										
Lacy Creek-Mouth	3					P				U		U																			C						C							U													C	
Source/Jacobson & Mono Creeks-Lacy Creek	3							C				C																																															
Wyman Creek	4							PE		PE		C	P																																												U	

Headwaters subbasin (continued)

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A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

Stream	Fisheries Resource Value Class	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
FAMILY		Sturgeon	Sturgeon	Paddlefish	Mooneye	Trout	Trout	Trout	Trout	Trout	Trout	Trout	Trout	Pike
RUBY RIVER DRAINAGE														
Coal Creek	6							P						
Cottonwood Creek														
4km Above Mouth-Mouth	4							R		R				
4.8km Above Mouth-4.0km Above Mouth	4							R						
EF Ruby River	4							U	U	C				
MF Ruby River	6							P	P	P				
Mill Creek														
National Forest-BN RR Bridge	4									U		C		
Leggat Creek-National Forest	4									R		C		
NF of Greenhorn Creek	1							U				C		
Ruby River #1														
National Forest-Ruby River Reservoir	3					U				A	U	R		
Warm Springs Creek-National Forest	3					C				C	C			
Three Forks Ruby River-Warm Springs Creek	4					C			C		R			
Coal Creek-Three Forks Ruby River	4							U	C	R				
Ruby River #2	2					C				R	A			
Warm Springs Creek														
Still Creek-Mouth	3					R		U		C	C			
Road-Buckskin Creek	4							A		U	C			
Headwaters-Road	3							C						
WF Ruby River	4							U	U	R		P		
Wisconsin Creek	5							P				P		
RED ROCK-BEAVERHEAD DRAINAGE														
Bear Creek	2							C				A		
Beaverhead River #1														
Clark Canyon Dam-Grasshopper Creek	1					A				C	A	U		
Beaverhead River #2														
Anderson Lane-Mouth	3					U				U	C	R		
Stodden Ditch-Anderson Lane	3					U				U	C	R		
Big Sheep Creek														
Irrigation Diversion-Mouth	4					PE			PE	PE	PE			
Shearing Pen Gulch-Irrigation Diversion	3					U			U	A	C			
Source-Shearing Pen Gulch	2									A	C			
Black Canyon Creek	6											P		
Blacktail Deer Creek														
East Bench Canal-Mouth	3					P				U	C			
Above E. Bench Canal-East Bench Canal	5									PE		PE		
W Fk. Blacktail Creek-2.4km Above E. Bench Canal	3					A				U		C		
Bloody Dick Creek														
National Forest-Mouth	3					U				C		A		
Park Creek-National Forest	3					C				A		A		
Browns Canyon Creek	6							P						
Cabin Creek	2							C						
Corral Creek	2							U				A	U	
Deadman Creek	3							P	A	P				

Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
FAMILY	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow
RUBY RIVER DRAINAGE																	
Coal Creek																	
Cottonwood Creek																	
4km Above Mouth-Mouth																	
4.8km Above Mouth-4.0km Above Mouth																	
EF Ruby River																	PE
MF Ruby River																	
Mill Creek																	
National Forest-BN RR Bridge																	
Leggat Creek-National Forest																	
NF of Greenhorn Creek																	
Ruby River #1																	
National Forest-Ruby River Reservoir																	P
Warm Springs Creek-National Forest																	P
Three Forks Ruby River-Warm Springs Creek																	P
Coal Creek-Three Forks Ruby River																	PE
Ruby River #2	P																P
Warm Springs Creek																	
Still Creek-Mouth																	A
Road-Buckskin Creek																	
Headwaters-Road																	
WF Ruby River																	PE
Wisconsin Creek																	
RED ROCK-BEAVERHEAD DRAINAGE																	
Bear Creek																	
Beaverhead River #1																	
Clark Canyon Dam-Grasshopper Creek	R																U
Beaverhead River #2																	
Anderson Lane-Mouth	U																A
Stodden Ditch-Anderson Lane	U																A
Big Sheep Creek																	
Irrigation Diversion-Mouth																	
Shearing Pen Gulch-Irrigation Diversion																	
Source-Shearing Pen Gulch																	A
Black Canyon Creek																	
Blacktail Deer Creek																	
East Bench Canal-Mouth																	P
Above E. Bench Canal-East Bench Canal																	
W Fk. Blacktail Creek-2.4km Above E. Bench Canal																	A
Bloody Dick Creek																	
National Forest-Mouth																	
Park Creek-National Forest																	
Browns Canyon Creek																	
Cabin Creek																	
Corral Creek																	
Deadman Creek																	

Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
FAMILY	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Catfish	Catfish	Catfish	Codfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Perch	Perch	Perch	Perch	Drum	Sculpin	Stickleback
RUBY RIVER DRAINAGE																											
Coal Creek																											
Cottonwood Creek																											
4km Above Mouth-Mouth																										U	
4.8km Above Mouth-4.0km Above Mouth																										U	
EF Ruby River							PE																			P	
MF Ruby River																										P	
Mill Creek																											
National Forest-BN RR Bridge																											
Leggat Creek-National Forest																											
NF of Greenhorn Creek																											
Ruby River #1																											
National Forest-Ruby River Reservoir							C	P	P																	P	
Warm Springs Creek-National Forest							U																			P	
Three Forks Ruby River-Warm Springs Creek																											
Coal Creek-Three Forks Ruby River							PE																			PE	
Ruby River #2							P	P																		P	
Warm Springs Creek																											
Still Creek-Mouth						A			U			A															
Road-Buckskin Creek																											
Headwaters-Road																											
WF Ruby River							PE																			PE	
Wisconsin Creek																										P	
RED ROCK-BEAVERHEAD DRAINAGE																											
Bear Creek																										C	
Beaverhead River #1																											
Clark Canyon Dam-Grasshopper Creek						C	U		U				U													A	
Beaverhead River #2																											
Anderson Lane-Mouth						C	U		R				U													A	
Stodden Ditch-Anderson Lane						C	U		R				U													A	
Big Sheep Creek																											
Irrigation Diversion-Mouth						PE	PE																				
Shearing Pen Gulch-Irrigation Diversion						C	C																				
Source-Shearing Pen Gulch																										A	
Black Canyon Creek																										P	
Blacktail Deer Creek																											
East Bench Canal-Mouth							C	C																			
Above E. Bench Canal-East Bench Canal																											
W Fk. Blacktail Creek-2.4km Above E. Bench Canal																										A	
Bloody Dick Creek																											
National Forest-Mouth																										PE	
Park Creek-National Forest																										A	
Browns Canyon Creek																											
Cabin Creek																											
Corral Creek						P																				A	
Deadman Creek																										A	

Headwaters subbasin (continued)

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	FAMILY	Sturgeon		Paddlefish	Mooneye	Trout							Pike	Minnow																	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
Stream	Fisheries Resource Value Class / COMMON NAME	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
EF Blacktail Deer Creek																																																										
Headwaters-National Forest	4							C	U	U		A																																													C	
National Forest-Mouth	3					C		C	U	C		A																																													C	
EF Clover Creek	4							C				A																																													A	
EF of Dyce Creek	6								P			P																																														
Frying Pan Creek	6							P																																																		
Grasshopper Creek																																																										
Reservoir Creek-Mouth	4					U				U	U	P																			A						C	C																			C	
National Forest-Reservoir Creek	4								P	P		P																																														
Hell Roaring Creek																																																										
Hell Roaring Canyon-New Mouth	1							U				U	U																																													
0.8km Above Lillian Lake-Hell Roaring Canyon	4							U				U																																														
Horse Prairie Creek																																																										
Bloody Dick Creek-Clark Canyon	3									C	C	C																																P														PE	
Maiden Creek-Bloody Dick Creek	4									C	U	C																																													PE	
Indian Creek	2							C																																																		
Jones Creek																																																										
RD. End 2.4km Above-RD. Xing at Wolfe Corrals	3							C																																																	P	
280m Up Right FK Above Forks-Road End/Conifer Edge	3							C																																																		
Long Creek	3							C				R																									C																				A	
Medicine Lodge Creek	3									C	PE	A																																													C	
Narrows Creek	2							A	P	P			A																																													
Odell Creek																																																										
Refuge-Lower Red Rock Lake	2					PE		U	U	U		U	C																								A	A																				
County Road-Refuge	2					PE		PE	U	U		C	A																								A	A																				
0.4km Above Spring Creek-County Road	2							C																																																		
Headwaters-0.4km Above Spring Creek	2							C																																																		
Peet Creek	2							A																																																	C	
Poindexter Slough	1					P				C	A	P																									P	P																			P	
Rape Creek	1							A																																																		
Red Rock Creek																																																										
Upper Red Rock Lake-Lower Red Rock Lake	3							PE				PE	U																								PE	PE						U														
Hell Roaring Creek Orig. Mouth-Upper Red Rock Lake	1							A				C	A																																												PE	
Source-Hell Roaring Creek Original Mouth	4									PE		PE	U																																													
Red Rock River #1	4																																					C						U														
Red Rock River #2																																																										
Big Sheep Creek-Mouth	2					P				C	A	P			U																						A	A						U													P	
Lima Reservoir-Big Sheep Creek	3					P				C	C	U																			P						PE	PE						C													P	
Reservoir Creek	6							P																																																		
Shenon Creek	4							U	U			U																																													U	
Simpson Creek	2							U																																																		
Tom Creek	3											C	U																								PE	PE																			U	
Trapper Creek	6							P				P																																														
WF Blacktail Deer Creek	4									U		A																																													A	
WF of Dyce Creek	6							P				P																																														

Upper Missouri subbasin

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	FAMILY	Sturgeon		Paddlefish	Mooneye	Trout								Pike	Minnow																	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
Stream	Fisheries Resource Value Class / COMMON NAME	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
UPPER MISSOURI RIVER DRAINAGE																																																										
Avalanche Creek	4								C																																																C	
Beaver Creek																																																										
Town of Nelson-Mouth	3							U	R	U	U	U																										U																			U	
Headwaters-Town of Nelson	3							U	U	U	R	U																																													U	
Beaver Creek																																																										
National Forest-Mouth	4									P		A																																													C	
S.Fk. Beaver Creek-National Forest	4								U			A																																													U	
1920 Meter Elevation-S.Fk. Beaver Creek	4								C			C																																														
Canyon Creek	4									C	R	C																																													C	
Confederate Gulch																																																										
National Forest-Ditch Head In Section 16	4							C				A																																													C	
Cement Gulch-National Forest	4								U	P	P	A																																														
Cottonwood Creek	4									U	P	C																																													C	
Crow Creek																																																										
Radersburg-Mouth	4					U				U																																																
National Forest-Radersburg	3									C	R	C																																													A	
Hall Creek-National Forest	3									A		C																																													C	
Crow Creek Falls-Begin Gorge	4									U		C																																													U	
Jct. Wilson/Tizer Creeks-Crow Creek Falls	4									U		C																																														
Deep Creek																																																										
Headwaters-National Forest	3							R		C		C																																													U	
National Forest-County Road	4							PE		C	C	U																																													U	
County Road-Mouth	4							PE		U	U	U																																													U	
Dry Creek																																																										
Source-National Forest	3							U		C		C																																													C	
National Forest-Mouth	4							U	P	C		C																																													C	
Duck Creek																																																										
Gold Mines-Irrigation Ditch	4							R		U		C																																													C	
Irrigation Ditch-Mouth	4							U		C	C	A			U																							PE																				
Little Prickly Pear Creek #1	2					U				C	C	U																									U	U																			C	
Little Prickly Pear Creek #2	2					U				C	C	U																									U	U																			C	
Lyons Creek	4									U	P	U																																													C	
McGuire Creek	6									P			P	P																																											P	
Missouri River #1																																																										
Canyon Ferry Reservoir-Toston Dam	1					A		P		C	C	P			R			PE	R												U						U	U		U			C	U					R			P					C	
Toston Dam-Three Forks	3					A		PE		C	C	PE			R			PE	U												U						U	U		U				U					R			PE					C	
Missouri River #2	1					C	U	R		A	A				U																						C	C														U		R			C	
Prickly Pear Creek #1																																																										
Begin Private Land-End Private Land	4											C																																														
4.8km Above National Forest-National Forest	2							C				C																																														
National Forest-Clancy Creek	3									C		C																																													C	
Prickly Pear Creek #2																																																										
Clancy Creek-County Road Crossing	3							P		A	A	U																									A	U																			C	
County Road Crossing-Mouth	4									U	U	U																									C	C																				
Sevenmile Creek	4									C	U	U																																													R	
Silver Creek	3						P	C		P	P	P																																													C	

Upper Missouri subbasin (continued)

Key to Symbols: 1=outstanding 2=high value 3=substantial 4=moderate 5=limited 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

FAMILY		Sturgeon		Paddlefish	Mooneye	Trout								Pike
Stream	Fisheries Resource Value Class	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
Sixteenmile Creek														
Headwaters-Higgins Reservoir	3									A	U	A		
Higgins Reservoir-Sixteen	3									A	U	A		
Sixteen-Maudlow	3					C		C		A	A			
Maudlow-Mouth	3					A				A	A			
Spokane Creek	3								P	P			C	C
Stickney Creek	3							R		C		U		
Tenmile Creek														
National Forest-Road 356	4									C		U		
Below Rimini-National Forest	4									U		U		
National Forest - Mouth	6									P	P	P		
Trout Creek	3						C		P	U	C			
Unnamed Tributary of Tenmile Creek	6									R				
Virginia Creek	4									P	P	C		
Warm Springs Creek	6										PE			
Wegner Creek	6									C				
Whiskey Springs	6													
Willow Creek	3							P	P	U		C		
Wolf Creek	3					U		R		C	R	C		
MISSOURI RIVER DRAINAGE - Holter Dam to Belt Creek														
Missouri River #3														
Sand Coulee Creek-Black Eagle	3					C				U	U			
Smith River-Sand Coulee Creek	3					C				U	U			
Cascade Bridge-Smith River	3					C				C	U			
Sheep Creek-Cascade Bridge	1					C				A	U			
Dearborn River-Sheep Creek	1					A		R		A	U			
Holter Dam-Dearborn River	1					A	R	R		A	U			
Missouri River #4														
Black Eagle Dam-Morony Dam	3					U				U	U			
DEARBORN RIVER DRAINAGE														
Dearborn River														
National Forest-Mouth	3					C				C	C	U		
Near Headwaters-National Forest	3							U		C		U		
Flat Creek	4					P				U	U	U		
Middle Fork Dearborn River	4									U		U		
Sheep Creek	3					C				C	U	U		
South Fork Dearborn River	4									U		U		
SMITH RIVER DRAINAGE														
Big Birch Creek														
National Forest-Mouth	4					C		U		U	R	A		
Near Forks-National Forest	4							U		U		C		
Eagle Creek	4							R		C		C		
Hound Creek	3					C				C	C	U		
Newlan Creek														
National Forest-Mouth	4					C		P		U		C		
Jct Sec 11/12-National Forest	4									U		C		

FAMILY	Minnow																
Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
Sixteenmile Creek																	
Headwaters-Higgins Reservoir																	
Higgins Reservoir-Sixteen																	
Sixteen-Maudlow																	
Maudlow-Mouth																	
Spokane Creek																	
Stickney Creek																	
Tenmile Creek																	
National Forest-Road 356																	
Below Rimini-National Forest																	
National Forest - Mouth																	
Trout Creek																	
Unnamed Tributary of Tenmile Creek																	
Virginia Creek																	
Warm Springs Creek																	
Wegner Creek																	
Whiskey Springs				P													
Willow Creek																	
Wolf Creek																	
MISSOURI RIVER DRAINAGE - Holter Dam to Belt Creek																	
Missouri River #3																	
Sand Coulee Creek-Black Eagle	C																P
Smith River-Sand Coulee Creek	C																P
Cascade Bridge-Smith River	C																
Sheep Creek-Cascade Bridge	U						C									C	A
Dearborn River-Sheep Creek	U						U									U	A
Holter Dam-Dearborn River	U																A
Missouri River #4																	
Black Eagle Dam-Morony Dam	U				C											C	C
DEARBORN RIVER DRAINAGE																	
Dearborn River																	
National Forest-Mouth																	C
Near Headwaters-National Forest																	
Flat Creek																	
Middle Fork Dearborn River																	
Sheep Creek																	
South Fork Dearborn River																	
SMITH RIVER DRAINAGE																	
Big Birch Creek																	
National Forest-Mouth																	
Near Forks-National Forest																	
Eagle Creek																	
Hound Creek																	
Newlan Creek																	
National Forest-Mouth																	
Jct Sec 11/12-National Forest																	

FAMILY	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
Sixteenmile Creek																											
Headwaters-Higgins Reservoir																										C	
Higgins Reservoir-Sixteen																										C	
Sixteen-Maudlow						PE	PE																			C	
Maudlow-Mouth						C	C																			C	
Spokane Creek																										PE	
Stickney Creek																										C	
Tenmile Creek																											
National Forest-Road 356						U	U																			A	
Below Rimini-National Forest																										C	
National Forest - Mouth																										P	
Trout Creek						U																				C	
Unnamed Tributary of Tenmile Creek																											
Virginia Creek																										C	
Warm Springs Creek																											
Wegner Creek																											
Whiskey Springs																											
Willow Creek																										C	
Wolf Creek							U																			C	
MISSOURI RIVER DRAINAGE - Holter Dam to Belt Creek																											
Missouri River #3																											
Sand Coulee Creek-Black Eagle						C	C			C		C	P			R		R		R	C					C	
Smith River-Sand Coulee Creek						C	C			P		C	U					R		R	C		U			C	
Cascade Bridge-Smith River						C	C					U	U										U			C	
Sheep Creek-Cascade Bridge						C	C						R		R			R			U		R			C	
Dearborn River-Sheep Creek						C	C						U								U		R			C	
Holter Dam-Dearborn River						C	C						U								U		U			C	
Missouri River #4																											
Black Eagle Dam-Morony Dam						C	C			U		U			R						U					C	
DEARBORN RIVER DRAINAGE																											
Dearborn River																											
National Forest-Mouth						C	C																			C	
Near Headwaters-National Forest																										C	
Flat Creek																											
Middle Fork Dearborn River							P																			C	
Sheep Creek						C	C																			C	
South Fork Dearborn River																											
SMITH RIVER DRAINAGE																											
Big Birch Creek																											
National Forest-Mouth																										C	
Near Forks-National Forest																											
Eagle Creek																											
Hound Creek																										C	
Newlan Creek																											
National Forest-Mouth																										C	
Jct Sec 11/12-National Forest																										C	

Upper Missouri subbasin (continued)

Key to Symbols: 1=outstanding; 2=high value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

FAMILY		Sturgeon		Paddlefish	Mooneye	Trout								Pike
Stream	**Fisheries Resource Value Class**	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
North Fork Deep Creek	6							C						
North Fork Smith River	6									P	P	P		
Rock Creek	3					C		U		C	U	U		
Sheep Creek														
Jumping Creek-Mouth	2					C		R		C	R	U		
Jct Sec 3/10-Jumping Creek	3					C		R		R		C		
Smith River #1														
Forks-Fort Logan Bridge	3					A				A	C	U		
Fort Logan Bridge-Sheep Creek	2					A		R		C	U	R		
Smith River #2														
Canyon-Hound Creek	2					C				C	U			
Rock Creek-Canyon	2					A		R		C	U	R		
Sheep Creek-Rock Creek	2					A		R		C	U	R		
Smith River #3														
Truly Bridge-Mouth	4					U					R			
Hound Creek-Truly Bridge	3					A		C		U	U	P		
South Fork Smith River	6										P	P		
Tenderfoot Creek														
National Forest-Mouth	3					C				C	R	U		
Headwaters-National Forest	3							C		C		R		
SUN RIVER DRAINAGE														
Big Coulee	6													
Elk Creek	3					U		R		C	U	C		
Ford Creek														
National Forest-Nilan Reservoir	4									U		C		
Near Upper End-National Forest	4							P		U		U		
Muddy Creek														
1 Mile Above Cleiv-Near Mouth	4									C				
Near Power-Mouth	4					C				U	R			
North Fork Willow Creek	6											P		
Sun River #1														
National Forest-Elk Creek	3					C				U	U	R	PE	
Sun River #2														
Elk Creek-Muddy Creek	3					U				R	R	R		U
Unnamed Tributary of Smith Creek	6													
Willow Creek	4									U		C		
BELT CREEK DRAINAGE														
Belt Creek #1														
Riceville Bridge-Big Willow Creek	3				C	C				C	U			
0.5km Below Dry Fork-Riceville Bridge	3					C		U		C	U	U		
Jefferson Creek-0.5km Below Dry Fork	3					C		U		C	R	U		
Belt Creek #2														
Big Willow Creek-Mouth	3				A					R				
Riceville Bridge-Big Willow Creek	3				C	C				C	U			
Big Otter Creek	6													
Dry Fork Belt Creek	3							C		U		U		

FAMILY	Minnow																
Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
North Fork Deep Creek																	
North Fork Smith River																	
Rock Creek																	
Sheep Creek																	
Jumping Creek-Mouth																	
Jct Sec 3/10-Jumping Creek																	
Smith River #1																	
Forks-Fort Logan Bridge																	C
Fort Logan Bridge-Sheep Creek																	C
Smith River #2																	
Canyon-Hound Creek																	U
Rock Creek-Canyon																	U
Sheep Creek-Rock Creek																	U
Smith River #3																	
Truly Bridge-Mouth	U	U															
Hound Creek-Truly Bridge																	P
South Fork Smith River																	
Tenderfoot Creek																	
National Forest-Mouth																	
Headwaters-National Forest																	
SUN RIVER DRAINAGE																	
Big Coulee																	
Elk Creek																	U
Ford Creek																	
National Forest-Nilan Reservoir																	
Near Upper End-National Forest																	
Muddy Creek																	
1 Mile Above Cleiv-Near Mouth					C												C
Near Power-Mouth					C												C
North Fork Willow Creek																	
Sun River #1																	
National Forest-Elk Creek		C															C
Sun River #2																	
Elk Creek-Muddy Creek	U	C			PE		P									C	C
Unnamed Tributary of Smith Creek																	
Willow Creek																	
BELT CREEK DRAINAGE																	
Belt Creek #1																	
Riceville Bridge-Big Willow Creek	U																C
0.5km Below Dry Fork-Riceville Bridge																	
Jefferson Creek-0.5km Below Dry Fork																	
Belt Creek #2																	
Big Willow Creek-Mouth	C																
Riceville Bridge-Big Willow Creek	U																C
Big Otter Creek																	
Dry Fork Belt Creek																	

FAMILY	Sucker									Catfish			Codfish
Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot
North Fork Deep Creek													
North Fork Smith River													
Rock Creek													
Sheep Creek													
Jumping Creek-Mouth													
Jct Sec 3/10-Jumping Creek													
Smith River #1													
Forks-Fort Logan Bridge						C	C						
Fort Logan Bridge-Sheep Creek						C	C		U				R
Smith River #2													
Canyon-Hound Creek						C	C		R			R	R
Rock Creek-Canyon						C	C		R			R	R
Sheep Creek-Rock Creek						C	C		R				R
Smith River #3													
Truly Bridge-Mouth						C	C						
Hound Creek-Truly Bridge						C	C		R			R	R
South Fork Smith River													
Tenderfoot Creek													
National Forest-Mouth													
Headwaters-National Forest													
SUN RIVER DRAINAGE													
Big Coulee							R						
Elk Creek						C	C						
Ford Creek													
National Forest-Nilan Reservoir						C	C						
Near Upper End-National Forest													
Muddy Creek													
1 Mile Above Cleiv-Near Mouth						C	C		C				
Near Power-Mouth						C	C						
North Fork Willow Creek													
Sun River #1													
National Forest-Elk Creek						C	C		U				
Sun River #2													
Elk Creek-Muddy Creek						U	A		P	C			R
Unnamed Tributary of Smith Creek													
Willow Creek						U	C						
BELT CREEK DRAINAGE													
Belt Creek #1													
Riceville Bridge-Big Willow Creek					A	C	C		U				
0.5km Below Dry Fork-Riceville Bridge						U	U		U				
Jefferson Creek-0.5km Below Dry Fork							U		PE				
Belt Creek #2													
Big Willow Creek-Mouth					C	C	C						
Riceville Bridge-Big Willow Creek					A	C	C		U				
Big Otter Creek													
Dry Fork Belt Creek													

FAMILY	Sunfish							Perch				Drum	Sculpin	Stickleback
Stream	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
North Fork Deep Creek														
North Fork Smith River														
Rock Creek													C	
Sheep Creek														
Jumping Creek-Mouth													C	
Jct Sec 3/10-Jumping Creek													C	
Smith River #1														
Forks-Fort Logan Bridge													C	
Fort Logan Bridge-Sheep Creek													C	
Smith River #2														
Canyon-Hound Creek													C	
Rock Creek-Canyon													C	
Sheep Creek-Rock Creek													R	
Smith River #3														
Truly Bridge-Mouth														
Hound Creek-Truly Bridge													P	
South Fork Smith River														
Tenderfoot Creek														
National Forest-Mouth													C	
Headwaters-National Forest													C	
SUN RIVER DRAINAGE														
Big Coulee														
Elk Creek													C	
Ford Creek														
National Forest-Nilan Reservoir													C	
Near Upper End-National Forest													C	
Muddy Creek														
1 Mile Above Cleiv-Near Mouth													C	
Near Power-Mouth													C	
North Fork Willow Creek													P	
Sun River #1														
National Forest-Elk Creek													C	
Sun River #2														
Elk Creek-Muddy Creek													U	
Unnamed Tributary of Smith Creek														
Willow Creek													C	
BELT CREEK DRAINAGE														
Belt Creek #1														
Riceville Bridge-Big Willow Creek									R				C	
0.5km Below Dry Fork-Riceville Bridge													PE	
Jefferson Creek-0.5km Below Dry Fork													PE	
Belt Creek #2														
Big Willow Creek-Mouth									U					
Riceville Bridge-Big Willow Creek									R				C	
Big Otter Creek														
Dry Fork Belt Creek														

Marias/Teton subbasin

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Stream	Fisheries Resource Value Class	Sturgeon		Paddlefish	Mooneye	Trout								Pike
		Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
Logging Creek	4									C		C		
Otter Creek	4									U	C	U		
Pilgrim Creek	2							C						
Tillinghast Creek	3					U						U		
MARIAS RIVER DRAINAGE														
Badger Creek	3							U		C		U		
Birch Creek	4					P				U		C		
Cut Bank Creek														
1mi Above Spring Creek-Mouth	3					U				U	U			
Indian Reservation-1mi Above Spring Creek	3					U				C	U			
Dry Fork Marias River	6													
Dupuyer Creek														
Lake Frances Diversion-Mouth	4					U				U		C		
Forks-Lake Frances Diversion	4					C				C		U		
Laughin Coulee	6													
Marias River														
Cut Bank Creek–Tiber Reservoir	3		R			C				U	U			U
Tiber Dam–Highway 223	3		C	R	A	A				U	U	R		U
Highway 223–Mouth	2		C	R	A	A				U	U	R		U
North Badger Creek														
Falls-Mouth	3									C		U		
Near Upper End-Falls	1							C						
North Fork Dupuyer Creek	3							C		U		U		
South Badger Creek	3							C		C		U		
South Fork Dupuyer Creek	2							U		U		U		
S.FK. Two Medicine River-Headwtrs.-Reservation Bndry.	2					U		C		C		U		
Timber Coulee	6													
Two Medicine River	4					U				U	U			
Unnamed Tributary of Bullhead Creek	6													
Unnamed Tributary of Campbell Coulee	6													
Whitetail Creek	6											P		
TETON RIVER DRAINAGE														
Alkalai Coulee	6													
Deep Creek	6													
Pishgun Road-Mouth	4				C	U				C		U		
Forks-Pishgun Road	4					U		U		C		U		
Gamble Coulee	6													
McDonald Creek	4											C		
Muddy Creek	6													
North Fork Deep Creek	2							U		U		C		
South Fork Deep Creek	4							U		U		C		
Spring Coulee	6									PE				
Spring Creek	3									C		C		
Teton River														
South Fork–Choteau	3				C	C				C	U	C		
Choteau–Highway 221	2				C	C				C	C	U		C
Unnamed Tributary of Teton River	6													

Stream	Minnow																
	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
Logging Creek																	
Otter Creek																	C
Pilgrim Creek																	
Tillinghast Creek																	
MARIAS RIVER DRAINAGE																	
Badger Creek																	
Birch Creek																	P
Cut Bank Creek																	
1mi Above Spring Creek-Mouth		C			U											U	C
Indian Reservation-1mi Above Spring Creek		C							C								C
Dry Fork Marias River																	
Dupuyer Creek																	
Lake Frances Diversion-Mouth		C															C
Forks-Lake Frances Diversion																	C
Laughin Coulee		P															
Marias River																	
Cut Bank Creek–Tiber Reservoir	U	C			U				U	C						C	U
Tiber Dam–Highway 223	C	C			A		R		R						R	U	A
Highway 223–Mouth	C	C			A		R		R						R	U	A
North Badger Creek																	
Falls-Mouth																	
Near Upper End-Falls																	
North Fork Dupuyer Creek																	
South Badger Creek																	
South Fork Dupuyer Creek																	
S.FK. Two Medicine River-Headwtrs.-Reservation Bndry.		C			U											U	C
Timber Coulee																	
Two Medicine River		C			U											U	C
Unnamed Tributary of Bullhead Creek																	
Unnamed Tributary of Campbell Coulee																	
Whitetail Creek																	
TETON RIVER DRAINAGE																	
Alkalai Coulee																	
Deep Creek																	
Pishgun Road-Mouth					U												C
Forks-Pishgun Road					U												C
Gamble Coulee																	
McDonald Creek																	
Muddy Creek																	
North Fork Deep Creek																	
South Fork Deep Creek																	
Spring Coulee		P															
Spring Creek																	C
Teton River																	
South Fork–Choteau	U	C														C	C
Choteau–Highway 221	C	C			U											C	C
Unnamed Tributary of Teton River																	

Stream	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
Logging Creek																										C	
Otter Creek						C	C																			C	
Pilgrim Creek																										C	
Tillinghast Creek																										C	
MARIAS RIVER DRAINAGE																											
Badger Creek																										P	
Birch Creek																										P	
Cut Bank Creek																											
1mi Above Spring Creek-Mouth						U	C		U				U													C	
Indian Reservation-1mi Above Spring Creek						U	C		U				R													C	
Dry Fork Marias River																											
Dupuyer Creek																											
Lake Frances Diversion-Mouth						C	C																			C	
Forks-Lake Frances Diversion							C		U																	C	
Laughin Coulee																										P	
Marias River																											
Cut Bank Creek–Tiber Reservoir				R		U					R		U								U		U			C	
Tiber Dam–Highway 223	C	U	U	U	C	A	C				C	U	U				PE				C	C	U		U	R	
Highway 223–Mouth	C	U	U	U	C	A	C				C	U	U				PE				C	C	U		U	R	
North Badger Creek																											
Falls-Mouth																										P	
Near Upper End-Falls																											
North Fork Dupuyer Creek																										U	
South Badger Creek																											
South Fork Dupuyer Creek																										U	
S.FK. Two Medicine River-Headwtrs.-Reservation Bndry.						U	C		U				U													C	
Timber Coulee																											
Two Medicine River						U	C	U																		U	
Unnamed Tributary of Bullhead Creek																											
Unnamed Tributary of Campbell Coulee																											
Whitetail Creek																											
TETON RIVER DRAINAGE																											
Alkalai Coulee																											
Deep Creek																											
Pishgun Road-Mouth						C	U																			C	
Forks-Pishgun Road						C	U																			C	
Gamble Coulee																											
McDonald Creek							C																			C	
Muddy Creek																											
North Fork Deep Creek																										C	
South Fork Deep Creek																										C	
Spring Coulee																											
Spring Creek						C	C		U																	C	
Teton River																											
South Fork–Choteau						U	C		U																	C	
Choteau–Highway 221					U	C	C		U		U		U									U				C	
Unnamed Tributary of Teton River																											

Middle Missouri subbasin

Key to Symbols: 1=outstanding; 2=high value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

FAMILY		Sturgeon		Paddlefish	Mooneye	Trout								Pike
Stream	**Fisheries Resource Value Class**	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
MISSOURI RIVER DRAINAGE–Belt Creek-Fort Peck Reservoir														
Big Dry Creek														
Jct Sec 4/5-Steves Creek	4													
1mi Above Mouth-Mouth	3				U									
Highwood Creek														
Shepard Crossing-Mouth	4									U		U		
National Forest-Shepard Crossing	3									U		C		
Chouteau County Line-National Forest	3							U		C		U		
Little Dry Creek	6													
Missouri River #4														
Morony Dam-Marias River	1	R	C	C	C	U				R	R			U
Missouri River #5 - Marias River-Judith River	1		C	R	A									
Missouri River #6 - Judith River-Fort Peck Reservoir	1	R	C	R	C									
Shonkin Creek	3									U		C		
JUDITH RIVER DRAINAGE														
Beaver Creek	4									U		C		
Big Sag Coulee	6													
Big Spring Creek #1														
Hwy 19 Bridge-Cottonwood Creek	1					U				A	C			
Upper Fish Hatchery-Hwy 19 Bridge	1					U				C	C			
Big Spring Creek #2	1				A	A				C	C			
Cottonwood Creek	4									U	U	C		
Cow Creek														
N & S Cow Creek-Reserv. Below County Road	4											A		
East Fork Big Spring Creek	6													
Judith River #1														
Ross Fork Creek-Warm Springs Creek	3				U	C				U	C			
Antelope Creek-Ross Fork Creek	4					U				U	U			
Forks-Antelope Creek	3					U				C	U	C		
Judith River #2														
Ross Fork Creek-Warm Springs Creek	3				U	C				U	C			
Warm Springs Creek-Missouri River	3				P									
Little Casino Creek	6													
Little Trout Creek	6													
Lost Fork Judith River	6													
Louse Creek	3											A		
McCarthy Creek	6													
MF Judith River	6													
Olsen Creek (Dawkins Spring)	6									P				
Ross Fork	6											P		
Running Wolf Creek	4									U	U	U		
South Fork Judith River	6													
Warm Springs Creek	3				C					C		U		
Wolf Creek	4									A				
Wolverine Creek	6													
Yogo Creek	4							U				C		

FAMILY	Minnow																
Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
MISSOURI RIVER DRAINAGE–Belt Creek-Fort Peck Reservoir																	
Big Dry Creek																	
Jct Sec 4/5-Steves Creek	C						U									C	
1mi Above Mouth-Mouth	U				A								C		C	C	C
Highwood Creek																	
Shepard Crossing-Mouth																	
National Forest-Shepard Crossing																	
Chouteau County Line-National Forest																	
Little Dry Creek	P																
Missouri River #4																	
Morony Dam-Marias River	C	C			C				C							C	C
Missouri River #5 - Marias River-Judith River	C				A	R	U		C						C	C	A
Missouri River #6 - Judith River-Fort Peck Reservoir	C				C	R		U	C			R	U		C	U	C
Shonkin Creek																	
JUDITH RIVER DRAINAGE																	
Beaver Creek																	U
Big Sag Coulee																	
Big Spring Creek #1																	
Hwy 19 Bridge-Cottonwood Creek	U						P									PE	C
Upper Fish Hatchery-Hwy 19 Bridge																PE	C
Big Spring Creek #2	U															PE	C
Cottonwood Creek																	
Cow Creek																	
N & S Cow Creek-Reserv. Below County Road																	C
East Fork Big Spring Creek																	
Judith River #1																	
Ross Fork Creek-Warm Springs Creek	U																C
Antelope Creek-Ross Fork Creek																	C
Forks-Antelope Creek																	
Judith River #2																	
Ross Fork Creek-Warm Springs Creek	U																C
Warm Springs Creek-Missouri River	P				P										P		P
Little Casino Creek																	
Little Trout Creek																	
Lost Fork Judith River																	
Louse Creek																	A
McCarthy Creek																	
MF Judith River																	
Olsen Creek (Dawkins Spring)																	
Ross Fork		P															
Running Wolf Creek																	
South Fork Judith River																	
Warm Springs Creek	C	A														C	C
Wolf Creek		C															
Wolverine Creek																	
Yogo Creek																	

FAMILY	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
MISSOURI RIVER DRAINAGE–Belt Creek-Fort Peck Reservoir																											
Big Dry Creek																											
Jct Sec 4/5-Steves Creek																					C						
1mi Above Mouth-Mouth			C	R			U			C	C										R						
Highwood Creek																											
Shepard Crossing-Mouth					C	C	C																			C	
National Forest-Shepard Crossing					C	C	C																			C	
Chouteau County Line-National Forest																										C	
Little Dry Creek							P				P												P				
Missouri River #4																											
Morony Dam-Marias River	C	U	C	U	C	C	C				C	C	C								U	C	U	R	C	U	
Missouri River #5 - Marias River-Judith River	C	C	C	C	A	A	U		R		U	C							R		U	C			C	R	
Missouri River #6 - Judith River-Fort Peck Reservoir	C	C	C	C	C	C	R				A	C	C						U		U	C			U	R	P
Shonkin Creek						C	C																			C	
JUDITH RIVER DRAINAGE																											
Beaver Creek						C	U																			A	
Big Sag Coulee																											
Big Spring Creek #1																											
Hwy 19 Bridge-Cottonwood Creek						A	A																			C	
Upper Fish Hatchery-Hwy 19 Bridge						C	C																			A	
Big Spring Creek #2					U	A	A															R				C	
Cottonwood Creek						C	C																			PE	
Cow Creek																											
N & S Cow Creek-Reserv. Below County Road							C																			C	
East Fork Big Spring Creek																											
Judith River #1																											
Ross Fork Creek-Warm Springs Creek					C	C	C		C													C				C	
Antelope Creek-Ross Fork Creek						C	U		C																	C	
Forks-Antelope Creek						C	U																			C	
Judith River #2																											
Ross Fork Creek-Warm Springs Creek					C	C	C		C													C				C	
Warm Springs Creek-Missouri River		P			P	P	P		P			P															
Little Casino Creek																											
Little Trout Creek																											
Lost Fork Judith River																											
Louse Creek						C																				A	
McCarthy Creek																											
MF Judith River																											
Olsen Creek (Dawkins Spring)																											
Ross Fork																										P	
Running Wolf Creek																											
South Fork Judith River																											
Warm Springs Creek					U	A	A		A		C						U					C				A	
Wolf Creek																											
Wolverine Creek																										A	
Yogo Creek																										PE	

Middle Missouri subbasin (continued)

Key to Symbols: 1=outstanding; 2=high value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

Stream	Fisheries Resource Value Class	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
FAMILY		Sturgeon		Paddlefish	Mooneye	Trout								Pike	Minnow																	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
MUSSELSHELL RIVER DRAINAGE																																																										
Alabaugh Creek	4									U		C																																												
American Fork Creek	4									PE	C	P																			PE						PE	PE																				
Big Elk Creek	4							R		U	C	A																			U								C																			
Careless Creek	6											P																			P							P																				
Checkerboard Creek	4					U				C	U	C																										U																			A	
Collar Gulch Creek	6							P																																																		
Cottonwood Creek																																																										
National Forest-Mouth	4									C	U	A																																													A	
Flatwillow Creek																																																										
E of Tyler Siding-Mouth	4									U	U	R																													U	PE											PE	PE				
Forks-E of Tyler Siding	4									C	R	C									P										C						A	A		C																	A	
Musselshell River #1	3					U				U	C				U				A									C		U	A					U	C	C		C			U															
Musselshell River #2																																																										
Deadm Basin Supply Canal Inlet-Rte 3 Bridge near Lavina	3					U				U	U				U				A									C		U	A					U	C	C		C			U															
Rte 3 Bridge near Lavina-Flatwillow Creek	2				C					PE					C				A				C		C			A		U	C	U				A	C	A		C		C	R		R			U					U					
Musselshell River #3																																																										
Flatwillow Creek-Mouth	2				A									U	C				A				U		A		U		U		C	C	U	R		C	C	C			U	A	U	PE								U	C			R		
Rte 3 Bridge near Lavina-Flatwillow Creek	2				C					PE					C				A				C		C			A		U	C	U				A	C	A		C		C	R		R			U					U					
North Fork Musselshell #1	3									U		A																			U						C	C																			A	
North Fork Musselshell #2	3					C				C	A	C																			U						C	C																			A	
South Fork Musselshell																																																										
Cottonwood Creek-Mouth						R				C	A																				C						C	U																			A	
Near Forks-Cottonwood Creek										A	U	A																			C						U	U																			A	
Spring Creek	4									U	U	A																																														
Swimming Woman Creek	6											P									P									P	P							P																				
SWAMPS AND LAKES																																																										
Antelope Butte Swamp	6											PE																										P																				
Bean Lake	6									P																												P																				

APPENDIX H

RECREATION INFORMATION FOR RIVERS AND STREAMS WITH RESERVATION REQUESTS

Table H-1. Recreation information for rivers and streams with reservation requests

BIG HOLE RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
American Creek	93	-	(n=2)	U	-	-	-	-	-	-	-	-
Bear Creek	138	-	(n=1)	U	-	-	-	-	-	-	-	-
Big Hole River (Headwaters-Pintlar Creek)	8,902	153	(n=3)									
Continental Divide-NF Big Hole River				2	F/SR	6	S	P	P	P	H/M	0
Big Hole River (Pintlar Creek-Divide Creek)	23,502	500	(n=4)									
NF Big Hole River-Divide Bridge				1	MR	6	S	P	P	P	H	4
Big Hole River (Divide Creek-Mouth)	21,005	412	(n=4)									
Divide Bridge-Beaverhead River				1	SR/MR	6	P	P	P	P	H	8
Big Lake Creek	105	-	(n=1)									
Twin Lakes-Big Hole River				2	NB	0	-	-	P	S	M	1
Birch Creek	137	-	(n=1)									
Anchor Lake-Forest Service Boundary				2	NB	0	-	-	S	P	H	2
Bryant Creek			(n=0)									
Headwaters-Big Hole River				3	NB	0	-	-	P	S	L	0
California Creek	648	-	(n=3)	U	-	-	-	-	-	-	-	-
Camp Creek	180	-	(n=2)									
Headwaters-Big Hole River				3	NB	0	-	-	P	P	M	0
Canyon Creek	278	-	(n=2)									
Headwaters-Mouth				1	NB	0	-	-	P	P	H	2
Corral Creek	268	-	(n=1)	-	-	-	-	-	-	-	-	-
Deep Creek	418	-	(n=3)									
Headwaters-French Creek				1	NB	0	-	-	P	S	L	1
Delano Creek			(n=0)	U	-	-	-	-	-	-	-	-
Divide Creek	634	-	(n=3)	U	-	-	-	-	-	-	-	-
Fishtrap Creek	452	-	(n=2)									
MF Big Hole River				U	NB	0	-	-	-	-	-	0
Francis Creek			(n=0)									
Headwaters-Steel Creek				3	NB	0	-	-	S	-	L	0
French Creek	239	-	(n=2)	U	-	-	-	-	-	-	-	-
Governor Creek	103	-	(n=3)									
Headwaters-Big Hole River				3	NB	0	-	-	-	-	L	0
Jacobsen Creek			(n=0)	-	-	-	-	-	-	-	-	-
Jerry Creek	655	-	(n=3)									
Headwaters-Mouth				3	NB	0	-	-	P	S	L	0

Column 1 = Angler days/year (average of 1982-1986 values)[a]
Column 2 = Angler days/year/river mile
Column 3 = Number of years in which fishing pressure has been measured
Column 4 = Recreational value—1 = outstanding; 2 = substantial; 3 = moderate; 4 = limited; U = unclassified
Column 5 = Water character—F = flat; SR = small rapids; MR = moderate rapids; LR = large rapids; NB = not boated
Column 6 = Months of year boatable
Column 7 = Boating/floating[b]
Column 8 = Boat fishing[b]
Column 9 = Shore fishing[b]
Column 10 = Shoreline activities[b]
Column 11 = Nonangler use estimate—H = high; M = moderate; L = low
Column 12 = Number of developed sites

[a] For this EIS, high angler use = more than 10,000 angler days per year for a given stream or river segment; moderate angler use = 1,000-10,000 angler days per year; low angler use = less than 1,000 angler days per year.

[b] For columns 7 through 10: P = primary activity, one of the main reasons for visiting this stream or river segment; S = secondary activity, an activity or use occurring on this stream, but not one of the most important uses

Sources: Columns 1 through 3: DFWP 1989_.
Columns 4 through 12: Natural Resource Information System 1989. Comprehensive recreation information is not available for all streams.

Big Hole River drainage (continued)	1	2	3	4	5	6	7	8	9	10	11	12
Johnson Creek	262	-	(n=3)									
Headwaters-Mouth				3	NB	0	-	-	P	S	M	0
Joseph Creek	273	-	(n=1)									
Chief Joseph Pass-Trail Creek				3	NB	0	-	-	P	S	L	0
LaMarche Creek	499	-	(n=3)									
Wilderness Boundary-Big Hole River				1	NB	0	-	-	P	P	M	0
Miner Creek	866	-	(n=4)									
Upper Miner Lake-Big Hole River				1	F	3	S	S	P	P	M	1
Moose Creek	137	-	(n=1)									
Humbug Spires-Big Hole River				3	NB	0	-	-	P	P	M	0
Mussigbrod Creek	232	-	(n=2)									
Wilderness Boundary-Big Hole River				2	NB	0	-	-	P	P	L	1
NF Big Hole River	1,571	-	(n=4)									
Battlefield-Big Hole River				U	NB	0	-	-	-	-	U	0
Oregon Creek			(n=0)									
Pattengail Creek	344	-	(n=2)									
Elbow Lake-Wise River				1	F	4	S	S	P	S	M	0
Pintlar Creek	722	-	(n=3)									
Wilderness Boundary-Big Hole River				2	NB	0	-	-	P	S	M	1
Rock Creek	701	-	(n=4)									
Continental Divide-Swamp Area				3	NB	0	-	-	S	S	L	0
Ruby Creek	394	-	(n=4)									
Headwaters-Trail Creek				3	NB	0	-	-	P	S	M	0
Sevenmile Creek	752	-	(n=1)	-	-	-	-	-	-	-	-	-
Seymour Creek	188	-	(n=1)									
Wilderness Boundary-Big Hole River				2	NB	0	-	-	P	S	H	2
Sixmile Creek			(n=0)									
SF Big Hole River			(n=0)									
Steel Creek	826	-	(n=2)									
Moose Meadow-Big Hole River				3	NB	0	-	-	P	P	M	1
Sullivan Creek			(n=0)									
Swamp Creek			(n=0)									
Yank Swamp-Big Hole River				3	NB	0	-	-	P	-	L	0
Tenmile Creek	376	-	(n=1)									
Trail Creek	538	-	(n=3)									
Gibbons Pass-NF Big Hole River				3	F	4	S	S	P	S	M	0
Trapper Creek	137	-	(n=1)									
Headwaters-Forest Service Boundary				2	NB	0	-	-	P	S	H	0
Twelvemile Creek	240	-	(n=2)									
Warm Springs Creek	568	-	(n=2)									
West Pioneers-Big Hole River				3	NB	0	-	-	P	S	L	0
Willow Creek	389	-	(n=1)									
Tendoy Lake-BLM Boundary				3	NB	0	-	-	S	P	M	0
Wise River	3,001	107	(n=4)									
Mono Creek-Big Hole River				2	SR	2	S	-	P	P	H	4
Wyman Creek	235	-	(n=2)									
Headwaters-Wise River				1	NB	0	-	-	P	S	H	0

GALLATIN RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Baker Creek	787	-	(n=3)	U	-	-	-	-	-	-	-	-
Ben Hart Spring Creek	100	-	(n=1)	U	-	-	-	-	-	-	-	-
Big Bear Creek			(n=0)	U	-	-	-	-	-	-	-	-
Bridger Creek	1,546	-	(n=4)	U	-	-	-	-	-	-	-	-
Cache Creek			(n=0)	U	-	-	-	-	-	-	-	-
EF Hyalite Creek			(n=0)									
Heather Lake-Hyalite Reservoir				1	NB	0	-	-	P	P	H	1

Gallatin River drainage (continued)	1	2	3	4	5	6	7	8	9	10	11	12
East Gallatin River (Headwaters-Mouth)	7,629	-	(n=4)									
Rocky/Bozeman Creek-Springhill Bridge				3	NB	0	S	-	P	-	M	-
East Gallatin River												
Springhill Bridge-Gallatin River				2	SR	6	S	S	P	-	L	0
Gallatin River (Spanish Cr.-Yellowstone Park)	14,619	357	(n=4)									
Yellowstone NP-WF Gallatin River				1	MR	4	P	P	P	S	H	2
Gallatin River (Spanish Cr.-EF Gallatin)	28,408	789	(n=4)									
WF Gallatin River-Greek Creek				1	MR	4	P	S	P	P	H	3
Greek Creek-Hwy. 191 Bridge				1	LR	4	P	-	P	S	H	2
Hwy. 191 Bridge-East Gallatin River				1	MR	4	P	P	P	P	H/M	4
Gallatin River (EF Gallatin-Mouth)	13,439	1,120	(n=4)									
EF Gallatin River-Missouri River				2	SR	7	S	S	P	S	H	1
Hell Roaring Creek	273	-	(n=1)									
Headwaters-Gallatin River				U	NB	0	-	-	-	-	-	0
Hyalite Creek (Mouth-Hyalite Reservoir)	2,800	-	(n=4)									
Hyalite Reservoir-Forest Service Boundary				2	NB	-	0	-	P	P	H	2
NF of the WF Gallatin River			(n=0)	U	-	-	-	-	-	-	-	-
Porcupine Creek	644	-	(n=1)									
Fortress Mountain-Gallatin River				2	NB	0	-	-	P	P	H	0
Reese Creek	20	-	(n=1)	U	-	-	-	-	-	-	-	-
Rocky Creek	638	-	(n=4)	U	-	-	-	-	-	-	-	-
Sourdough (Bozeman) Creek	90	-	(n=1)									
Headwaters-Forest Service Boundary				2	NB	0	-	-	P	P	H/M	0
Forest Service Boundary-E. Gallatin River				2	NB	0	-	-	P	S	H	1
South Cottonwood Creek	574	-	(n=1)									
Timber Butte-Forest Service Boundary				2	NB	0	-	-	P	P	M/L	0
SF Spanish Creek	182	-	(n=2)									
Spanish Lakes-Spanish Creek				U	NB	0	-	-	-	-	-	0
SF of the WF Gallatin River			(n=0)									
Headwaters-WF Gallatin River				3	NB	0	-	-	P	P	M	2
Spanish Creek			(n=0)									
Confluence NF &SF-Gallatin River				U	NB	0	-	-	-	-	-	0
Squaw Creek	367	-	(n=4)									
Divide Peak-Gallatin River				2	NB	0	-	-	P	P	M	2
Taylor Fork of the Gallatin River	763	-	(n=4)									
Wilderness Boundary-Gallatin River				2	NB	0	-	-	P	P	M	0
Thompson Spring Creek			(n=0)	U	-	-	-	-	-	-	-	-
WF Gallatin River	433	-	(n=3)									
Headwaters-Gallatin River				2	NB	0	-	-	P	P	H	1
WF Hyalite Cr. (Hyalite Reservoir-Hyalite Lake)	177	-	(n=2)									
Hyalite Peak-Hyalite Reservoir				1	NB	0	-	-	P	P	H	1

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Column 7 = Boating/floating[b]
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JEFFERSON RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Boulder River (Headwaters-Mouth)	2,543	33	(n=4)									
Headwaters-Bison Creek				3	F	3	S	-	P	P	M	3
Bison Creek-Jefferson River				3	SR/MR	2	S	S	P	-	M	0
Halfway Creek			(n=0)	U	-	-	-	-	-	-	-	-
Hells Canyon Creek			(n=0)	U	-	-	-	-	-	-	-	-
Jefferson River	21,125	251	(n=4)									
Big Hole/Beaver-Missouri River				2	SR/MR	5	P	P	P	P	H	7
Little Boulder River	571	-	(n=4)	U	-	-	-	-	-	-	-	-
North Willow Creek	336	-	(n=2)									
Hollowtop Lake-Forest Service Boundary				3	NB	0			P	P	L	0
South Boulder River	295	-	(n=2)	U	-	-	-	-	-	-	-	-
South Willow Creek	425	-	(n=3)									
Granite Lake-Forest Service Boundary				3	NB	0			P	S	H	1
Whitetail Creek	297	-	(n=2)	U	-	-	-	-	-	-	-	-
Willow Creek	2,042	-	(n=4)	U	-	-	-	-	-	-	-	-
Willow Spring Creek			(n=0)	U	-	-	-	-	-	-	-	-

MADISON RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Antelope Creek			(n=0)									
Saddle Mountain-Cliff Lake				3	NB	0	-	-	P	P	H	0
Beaver Creek	210	-	(n=3)	U	-	-	-	-	-	-	-	-
Black Sand Spring Creek			(n=0)	U	-	-	-	-	-	-	-	-
Blaine Spring Creek	297	-	(n=1)	U	-	-	-	-	-	-	-	-
Cabin Creek	68	-	(n=1)									
Headwaters-Quake Lake				U	NB	0	-	-	-	-	-	0
Cherry Creek	835	-	(n=4)	U	-	-	-	-	-	-	-	-
Cougar Creek	511	-	(n=1)	U	-	-	-	-	-	-	-	-
Duck Creek	1,504	-	(n=3)	U	-	-	-	-	-	-	-	-
Elk River			(n=0)	U	-	-	-	-	-	-	-	-
Grayling Creek	326	-	(n=2)	U	-	-	-	-	-	-	-	-
Hot Springs Creek	137	-	(n=1)									
Headwaters-Madison River				3	NB	0	-	-	P	S	L	1
Indian Creek	422	-	(n=2)									
Forest Service Boundary-Madison River				3	NB	0	-	-	P	S	L	1
Jack Creek	377	-	(n=3)									
Headwaters-Forest Service Boundary				2	NB	0	-	-	P	P	H	2
Madison R. (Yellowstone Pk-Hebgen Dam)	12,906	759	(n=4)	U	-	-	-	-	-	-	-	-
Madison River (Hebgen Dam-Ennis Lake)	40,636	589	(n=4)									
Hebgen Reservoir-Quake Lake				2	MR	4	S	P	S	S	H	2
Quake Lake-McAtee Bridge				1	SR/MR	6	S	P	P	P	H	>9
McAtee Bridge-Ennis Lake				1	SR	6	S	P	P	P	H	4
Madison River (Ennis Lake-Mouth)	36,742	919	(n=4)									
Ennis Lake Dam-Hot Springs Creek				1	LR	9	P	-	P	P	H	0
Hot Springs Creek-Missouri River				1	SR	9	S	P	P	P	H	5
Moore Creek			(n=0)	U	-	-	-	-	-	-	-	-
North Meadow Creek	133	-	(n=3)									
Headwaters-Ennis Lake				3	NB	0	-	-	P	P	M	0
O'Dell Spring Creek	771	-	(n=3)	U	-	-	-	-	-	-	-	-
Red Canyon Creek			(n=0)									
Headwaters-Hebgen Lake				U	NB	0	-	-	-	-	-	0
Ruby Creek	683	-	(n=1)									
Headwaters-Madison River				3	NB	0	-	-	P	S	M	1
SF Madison River	2,600	-	(n=4)	U	-	-	-	-	-	-	-	-

Madison River drainage (continued)	1	2	3	4	5	6	7	8	9	10	11	12
Squaw Creek	100	-	(n=1)									
Wilderness Boundary-Madison River				3	NB	0	-	-	P	-	L	0
Standard Creek			(n=0)									
Black Butte-Madison River				3	NB	0	-	-	P	S	M	0
Trapper Creek			(n=0)									
Coffin Mountain-Hebgen Lake				3	NB	0	-	-	-	S	M	0
Watkins Creek			(n=0)									
Idaho Border-Hebgen Lake				1	NB	0	-	-	P	P	M	1
WF Madison River	1,154	-	(n=4)									
Headwaters-Madison River				2	NB	0	-	-	P	P	L	1

RED ROCK-BEAVERHEAD DRAINAGES

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Bear Creek			(n=0)	U	-	-	-	-	-	-	-	-
Beaverhead River (Headwaters-Mouth)	22,356	283	(n=4)									
Clark Canyon Dam-Dillon				1	SR/MR	7	P	P	P	S	H/M	3
Dillon-Big Hole River				1	F/SR	8	P	P	P	S	H/M	3
Big Sheep Creek	735	-	(n=4)									
Nicholia-Red Rock River				2	NB	0	-	-	P	P	H	0
Black Canyon Creek			(n=0)									
Headwaters-Horse Prairie Creek				3	NB	0	-	-	-	S	L	0
Blacktail Deer Creek	1,956	-	(n=4)									
Confluence MF & WF-Beaverhead River				3	F	1	-	-	P	S	M	0
Bloody Dick Creek	2,404	-	(n=3)									
Headwaters-Horse Prairie Creek				3	NB	0	-	-	P	P	H	1
Browns Canyon Creek			(n=0)	U	-	-	-	-	-	-	-	-
Cabin Creek			(n=0)	U	-	-	-	-	-	-	-	-
Corral Creek	268	-	(n=1)	U	-	-	-	-	-	-	-	-
Deadman Creek	435	-	(n=1)									
Headwaters-Big Sheep Creek				1	NB	0	-	-	P	P	L	0
EF Blacktail Deer Creek	194	-	(n=1)									
Two Meadows-Blacktail Deer Creek				3	NB	0	-	-	P	P	H/M	0
EF Clover Creek			(n=0)									
Headwaters-Clover Creek				3	NB	0	-	-	P	S	M/L	0
EF Dyce Creek			(n=0)	U	-	-	-	-	-	-	-	-
Frying Pan Creek			(n=0)	U	-	-	-	-	-	-	-	-

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Red Rock-Beaverhead drainages (continued)	1	2	3	4	5	6	7	8	9	10	11	12
Grasshopper Creek	2,440	-	(n=4)									
Headwaters-Forest Boundary				1	NB	0	-	-	P	P	H	3
Forest Boundary-Bannack				1	NB	0	-	-	P	S	H	2
Bannack-Beaverhead River				3	SR	2	S	-	P	S	M/L	1
Hell Roaring Creek			(n=0)									
Headwaters-Red Rock Creek				3	NB	0	-	-	P	P	L	0
Horse Prairie Creek	105	-	(n=4)									
Headwaters-Clark Canyon Dam				3	NB	0	-	-	P	S	M	0
Indian Creek			(n=0)	U	-	-	-	-	-	-	-	-
Jones Creek			(n=0)	U	-	-	-	-	-	-	-	-
Long Creek	137	-	(n=1)									
Lone Butte-Red Rock River				3	NB	0	-	-	S	P	M	0
Medicine Lodge Creek	527	-	(n=4)									
Headwaters-Horse Prairie Creek				3	NB	0	-	-	P	S	M/L	0
Narrows Creek			(n=0)	U	-	-	-	-	-	-	-	-
Odell Creek	700	-	(n=1)									
Slide Mountain-Lower Red Rock Lake				U	NB	0	-	-	-	-	-	0
Peet Creek			(n=0)	U	-	-	-	-	-	-	-	-
Poindexter Slough	1,459	-	(n=4)	2	F	2	S	P	P	S	H/M	1
Rape Creek			(n=0)	U	-	-	-	-	-	-	-	-
Red Rock Creek	597	-	(n=3)									
Headwaters-Red Rock Refuge				2	F	3	P	-	P	P	M	0
Red Rock River (Lima Dam-Upper Red Rock Lake)	397	8	(n=2)									
Lower Red Rock Lake-Brundage Bridge				2	F	4	S	S	P	S	M	0
Brundage Bridge-Lima Reservoir				2	F/SR	4	S	S	P	S	M/L	0
Red Rock River (Lima Dam-Mouth)	2,928	51	(n=4)									
Lima Reservoir-Clark Canyon Reservoir				4	F/SR	7	P	P	P	S	L	1
Reservoir Creek			(n=0)	U	-	-	-	-	-	-	-	-
Shenon Creek			(n=0)	U	-	-	-	-	-	-	-	-
Simpson Creek			(n=0)	U	-	-	-	-	-	-	-	-
Tom Creek			(n=0)	U	-	-	-	-	-	-	-	-
Trapper Creek	137	-	(n=1)	U	-	-	-	-	-	-	-	-
WF Blacktail Deer Creek			(n=0)									
Headwaters-Blacktail Creek				3	NB	0	-	-	P	S	M	0
WF Dyce Creek			(n=0)	U	-	-	-	-	-	-	-	-

RUBY RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Coal Creek			(n=0)	U	-	-	-	-	-	-	-	-
Cottonwood Creek			(n=0)									
Geyer Creek-Ruby River				3	NB	0	-	-	P	P	H	1
EF Ruby River			(n=0)									
Gravelly Ridge-Ruby River				2	NB	0	-	-	P	S	M	0
MF Ruby River			(n=0)	U	-	-	-	-	-	-	-	-
Mill Creek	415	-	(n=1)									
Branham Lakes-Ruby River				2	NB	0	-	-	P	P	H	4
NF Greenhorn Creek			(n=0)	U	-	-	-	-	-	-	-	-
Ruby River (Headwaters-Ruby Reservoir)	1,040	19	(n=4)									
Headwaters-Ruby Reservoir				3	SR	2	S	-	P	P	H	0
Ruby River (Ruby Reservoir-Mouth)	5,725	119	(n=4)									
Ruby Reservoir-Beaverhead River				3	F/SR	5	S	S	P	S	M	1
Warm Springs Creek	429	-	(n=2)									
Romey Lake-Ruby River				2	NB	0	-	-	P	P	H	0
WF Ruby River			(n=0)									
Headwaters-Ruby River				2	NB	0	-	-	P	S	M	0
Wisconsin Creek			(n=0)									
Headwaters-Ruby River				3	NB	0	-	-	S	S	L	0

MISSOURI RIVER DRAINAGE-Three Forks to Holter Dam

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Avalanche Creek			(n=0)									
Thompson Creek-Canyon Ferry Lake				4	NB	0	-	-	P	S	L	0
Beaver Creek (above Canyon Ferry Dam)	1,288	-	(n=1)	U	-	-	-	-	-	-	-	-
Beaver Creek (below Canyon Ferry Dam)	925	-	(n=4)									
Porcupine Creek-Bear Gulch				3	NB	0	-	-	-	S	L	0
Bear Gulch-Missouri River				2	NB	0	-	-	P	S	M	2
Confederate Gulch	200	-	(n=1)	U	-	-	-	-	-	-	-	-
Cottonwood Creek			(n=0)	U	-	-	-	-	-	-	-	-
Crow Creek	1,252	-	(n=4)									
Tizer Creek-Radersburg				3	SR/MR	1	S	-	P	S	M	0
Radersburg-Missouri River				U	-	-	-	-	-	-	-	-
Deep Creek	602	-	(n=4)									
Skidway Campground-Ross Gulch				3	NB	0	-	-	P	S	M	2
Dry Creek	2,717	-	(n=4)	U	-	-	-	-	-	-	-	-
Duck Creek	150	-	(n=1)	U	-	-	-	-	-	-	-	-
McGuire Creek			(n=0)	U	-	-	-	-	-	-	-	-
Missouri River (Headwtrs-Canyon Ferry Dam)	11,162	167	(n=4)									
Headwaters State Park-Canyon Ferry Lake				2	F	9	P	P	P	P	H	4
Missouri River (Hauser Dam-Holter Dam)	15,656	602	(n=4)	U	F	8	S	P	P	P	H	7
Prickly Pear Creek (Headwaters-Mouth)	2,596		(n=4)									
Rabbit Gulch-Forest Service Boundary				3	NB	0	-	-	P	S	L	0
Forest Service Boundary-East Helena				4	F/SR	3	S	S	P	S	M	0
Sevenmile Creek	138	-	(n=1)	U	-	-	-	-	-	-	-	-
Silver Creek			(n=0)	U	-	-	-	-	-	-	-	-
Sixteenmile Creek	3,621	-	(n=4)									
Ringling-MF				4	NB	0	-	-	P	-	L	0
MF Confluence-Missouri River				3	SR	1	-	-	P	S	L	0
Spokane Creek			(n=0)	U	-	-	-	-	-	-	-	-
Tenmile Creek	633	-	(n=3)									
Minnehaha Creek-Lazyman Trailhead				3	NB	0	-	-	P	P	M	3
Trout Creek	1,373	-	(n=2)									
Vigilante Camp-Missouri River				4	NB	0	-	-	-	S	M	1
Warm Springs Creek	273	-	(n=1)	U	-	-	-	-	-	-	-	-
Willow Creek	621	-	(n=4)	U	-	-	-	-	-	-	-	-

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MISSOURI RIVER DRAINAGE-Holter Dam to Belt Creek

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Canyon Creek	647	-	(n=4)									
Headwaters-Virginia Creek				4	NB	0	-	-	P	-	M/L	0
Virginia Creek-Prickly Pear Creek				U	NB	0	-	-	-	-	L	0
Little Otter Creek	1,305	-	(n=1)	U	-	-	-	-	-	-	-	-
Little Prickly Pear Creek (Headwaters-Mouth)	1,640	-	(n=4)									
NF & SF Little Prickly Pear-Sieben				3	NB	0	-	-	P	-	M	0
Sieben-Missouri River				2	SR	3	P	-	P	P	H	2
Lyons Creek	212	-	(n=1)	U	-	-	-	-	-	-	-	-
Missouri River (Holter Dam-Cascade Bridge)	53,477	1,528	(n=4)									
Missouri R. (Cascade Bridge-Morony Dam)	21,214	303	(n=4)									
Holter Dam-Great Falls				1	F	9	P	P	P	S	H	>9
Stickney Creek	122	-	(n=2)	U	-	-	-	-	-	-	-	-
Virginia Creek			(n=0)									
Stemple Pass-Canyon Creek				3	NB	0	-	-	P	-	L	0
Wegner Creek			(n=0)	U	-	-	-	-	-	-	-	-
Wolf Creek	1,359	-	(n=4)	U	-	-	-	-	-	-	-	-

DEARBORN RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Dearborn River	1,672	25	(n=4)									
Scapegoat Wilderness Bdy.-Falls Creek				3	NB	0	-	-	P	S	M	1
Falls Creek-Hwy. 200 Bridge				2	MR	4	P	S	P	S	M	0
Hwy. 200 Bridge-Hwy. 287 Bridge				3	F	3	P	-	P	-	L	0
Hwy. 287 Bridge-Missouri River				1	MR	3	P	S	P	S	H	0
Flat Creek	404	-	(n=4)	U	-	-	-	-	-	-	-	-
MF Dearborn River			(n=0)									
Green Creek-Dearborn River				3	NB	0	-	-	P	P	H	0
Sheep Creek	420	-	(n=1)	U	-	-	-	-	-	-	-	-
SF Dearborn River			(n=0)	U	-	-	-	-	-	-	-	-

SMITH RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Big Birch Creek			(n=0)									
Headwaters-Gipsy Creek				3	NB	0	-	-	P	P	L	0
Eagle Creek			(n=0)	U	-	-	-	-	-	-	-	-
Hound Creek	1,079	-	(n=4)	U	-	-	-	-	-	-	-	-
Newlan Creek	461	-	(n=4)									
Headwaters-Forest Service Boundary				4	NB	0	-	-	P	S	L	0
NF Deep Creek			(n=0)	U	-	-	-	-	-	-	-	-
NF Smith River	450	-	(n=3)	U	-	-	-	-	-	-	-	-
Rock Creek	2,131	-	(n=2)	U	-	-	-	-	-	-	-	-
Sheep Creek	1,342	-	(n=3)									
Moose Creek-Black Butte Creek				3	NB	0	-	-	P	S	M	1
Smith River (Headwaters-Hound Creek)	8,080	81	(n=4)									
Confluence NF & SF-Fort Logan Bridge				3	F	2	S	-	P	S	L	0
Fort Logan Bridge-Camp Baker				2	F	2	P	P	P	P	H/M	0
Camp Baker-Eden Bridge				1	SR	5	P	P	P	-	H	>9
Smith River (Hound Creek-Mouth)	4,541	189	(n=4)									
Eden Bridge-Missouri River				3	F	6	S	P	P	P	M	0
SF Smith River	736	-	(n=2)	U	-	-	-	-	-	-	-	-
Tenderfoot Creek	313	-	(n=3)									
Headwaters-SF Tenderfoot Creek				3	NB	0	-	-	P	P	L	0
SF Tenderfoot Creek-Smith River				2	SR	5	S	-	P	S	M/L	0

SUN RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Big Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Elk Creek	1,469	-	(n=4)									
Bunch Grass Creek-Forest Service Boundary				3	NB	0	-	-	P	P	M	2
Ford Creek	544	-	(n=2)									
Whitewater Creek-Forest Service Boundary				3	NB	0	-	-	P	P	H	2
Muddy Creek	105	-	(n=1)	U	-	-	-	-	-	-	-	-
NF Willow Creek			(n=0)	U	-	-	-	-	-	-	-	-
Smith Creek			(n=0)									
Sun River (Gibson Dam-Muddy Creek)	4,262	51	(n=4)									
US Hwy. 287-Muddy Creek				3	F	8	S	-	S	S	L	0
Muddy Creek-Mouth	2,455	136	(n=4)	3	F	8	S	-	S	S	L	0
Willow Creek	621	-	(n=4)									
Willow Creek Gorge-Little Willow Creek				3	NB	0	-	-	P	P	M	1

JUDITH RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Beaver Creek	782	-	(n=2)	U	-	-	-	-	-	-	-	-
Big Spring Creek (Headwtrs-Cottonwood Cr.)	8,196	390	(n=4)									
Headwaters-Highway 87				2	SR	9	S	-	P	S	H	2
Big Spring Creek (Cottonwood Creek-Mouth)	2,786	279	(n=4)									
Hwy. 87 Lewistown-Judith River				3	SR	9	S	P	P	P	M	1
Campbell Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Cottonwood Creek	450	-	(n=2)	U	-	-	-	-	-	-	-	-
Cow Creek	276	-	(n=1)	U	-	-	-	-	-	-	-	-
EF Big Spring Creek	817	-	(n=2)	U	-	-	-	-	-	-	-	-
Judith River (Headwaters-Plum Creek)	2,819	31	(n=4)									
MF & SF Judith River-Hwy. 1176 Bridge				3	SR	4	P	-	P	S	L	1
Judith River (Plum Creek-Mouth)	332	9	(n=4)									
Danvers Bridge-Anderson Bridge				3	MR	6	S	-	P	P	M	0
Anderson Bridge-Missouri River				3	F	2	S	-	P	S	L	0
Little Trout Creek			(n=0)									
Lost Fork Judith River	188	-	(n=1)	U	-	-	-	-	-	-	-	-
Louse Creek	435	-	(n=1)	U	-	-	-	-	-	-	-	-
McCarthy Creek			(n=0)	U	-	-	-	-	-	-	-	-
MF Judith River	734	-	(n=3)	U	-	-	-	-	-	-	-	-

Column 1 = Angler days/year (average of 1982-1986 values)[a]
Column 2 = Angler days/year/river mile
Column 3 = Number of years in which fishing pressure has been measured
Column 4 = Recreational value—1 = outstanding; 2 = substantial; 3 = moderate; 4 = limited; U = unclassified
Column 5 = Water character—F = flat; SR = small rapids; MR = moderate rapids; LR = large rapids; NB = not boated
Column 6 = Months of year boatable
Column 7 = Boating/floating[b]
Column 8 = Boat fishing[b]
Column 9 = Shore fishing[b]
Column 10 = Shoreline activities[b]
Column 11 = Nonangler use estimate—H = high; M = moderate; L = low
Column 12 = Number of developed sites

[a] For this EIS, high angler use = more than 10,000 angler days per year for a given stream or river segment; moderate angler use = 1,000-10,000 angler days per year; low angler use = less than 1,000 angler days per year.

[b] For columns 7 through 10: P = primary activity, one of the main reasons for visiting this stream or river segment; S = secondary activity, an activity or use occurring on this stream, but not one of the most important uses

Sources: Columns 1 through 3: DFWP 1989_.
Columns 4 through 12: Natural Resource Information System 1989. Comprehensive recreation information is not available for all streams.

Judith River drainage (continued)	1	2	3	4	5	6	7	8	9	10	11	12
Olsen Creek			(n=0)	U	-	-	-	-	-	-	-	-
Running Wolf Creek	988	-	(n=3)	4								
NF & SF-Forest Service Boundary				4	NB	-	-	-	P	S	L	0
SF Judith River	1,127	-	(n=4)	U	-	-	-	-	-	-	-	-
Unnamed tributary of Louse Creek			(n=0)	U	-	-	-	-	-	-	-	-
Warm Spring Creek	1,235	-	(n=4)									
Maiden-Judith River				4	F/SR	2	S	-	P	P	L	1
Yogo Creek	331	-	(n=4)									
Headwaters-MF Judith River				4	NB	0	-	-	P	S	M	0

BELT CREEK/MISSOURI DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Belt Creek (Headwaters-Mouth)	8,059	97	(n=4)									
Sec. 15-Monarch				3	MR	1	S	-	P	P	H/M	3
Monarch-Riceville				2	MR	4	P	-	P	S	M	1
Riceville Bridge-Missouri River				3	MR	6	P	-	P	P	H	1
Big Otter Creek			(n=0)									
Headwaters-Otter Creek				4	NB	0	-	-	S	S	M	0
Dry Fork Belt Creek			(n=0)									
Galena Creek-Belt Creek				3	NB	0	-	-	S	S	H	0
Logging Creek	591	-	(n=3)									
Mill Creek-Belt Creek				2	NB	0	-	-	P	P	M	2
Pilgrim Creek	2,575	-	(n=1)									
T14N R6E Sec.2-Belt Creek				2	NB	0	-	-	P	P	M/L	0
Tillinghast Creek	3,219	-	(n=1)									
Keegan Butte-Belt Creek				4	NB	0	-	-	P	S	L	0

MISSOURI RIVER DRAINAGE-Belt Creek to Fort Peck Reservoir

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Cut Bank Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Highwood Creek	1,211		(n=4)	U	-	-	-	-	-	-	-	-
Missouri River (Morony Dam-Marias River)	7,640	141	(n=4)									
Morony Dam-Fort Benton				2	MR	9	P	P	P	P	H	1
Missouri River (Marias River-Fort Peck Dam)	5,225	19	(n=4)									
Fort Benton-Robinson Bridge				U	F	8	P	S	P	P	H	8
Robinson Bridge-Turkey Joe				1	F	6	P	P	S	S	M	6
Shonkin Creek	1,642	-	(n=4)	U	-	-	-	-	-	-	-	-

MARIAS RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Alkali Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Badger Creek	261	-	(n=2)									
NF & SF Badger Cr.-Forest Service Boundary				3	NB	0	-	-	P	P	L	0
Forest Service Boundary-Mouth				3	SR	3	S	-	P	-	M	0
Bean Lake	7,215	-	(n=4)	U	-	-	-	-	-	-	-	-
Birch Creek	231	-	(n=2)									
Swift Dam-Marias River				4	SR	3	S	-	P	S	M	0
Cut Bank Creek (Cut Bank-Mouth)	386	-	(n=3)									
Sharp Lake-Sullivan Bridge (Mouth)				3	SR	3	S	-	P	-	L	0
Dry Fork Marias			(n=0)	U	-	-	-	-	-	-	-	-
Dupuyer Creek	620	-	(n=4)									
Confluence NF & SF-Dupuyer				U	NB	0	-	-	-	-	-	1

Marias River drainage (continued)	1	2	3	4	5	6	7	8	9	10	11	12
Gamble Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Laughlin Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Marias River (Cut Bank Creek-Lake Elwell)	1,924	21	(n=3)									
Cut Bank Creek-Tiber Reservoir				3	F	5	S	-	P	-	M	0
Marias River (Tiber Dam-Mouth)	3,156	39	(n=4)									
Tiber Reservoir-Circle Bridge				2	F	9	S	-	P	S	M/L	1
Circle Bridge-Missouri River				2	F/MR	9	S	S	P	S	M	0
Muddy Creek			(n=0)									
North Badger Creek			(n=0)									
Pool Creek-SF Badger Creek				3	NB	0	-	-	P	P	M	0
NF Dupuyer Creek			(n=0)									
Bob Marshall Wild.-SF Dupuyer Creek				3	NB	0	-	-	S	S	M	0
South Badger Creek			(n=0)									
Crucifixion Creek-SF Badger Creek				4	NB	0	-	-	P	S	L	0
SF Dupuyer Creek	105	-	(n=1)									
Bob Marshall Wild.-NF Dupuyer Creek				4	NB	0	-	-	S	S	L	0
SF Two Medicine River	344	-	(n=1)									
Forest Service Boundary-Sullivan Bridge				2	NB	0	-	-	P	S	L	0
Spring Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Timber Coulee			(n=0)	U	-	-	-	-	-	-	-	-
Two Medicine River	806	-	(n=3)									
Forest Service Boundary-Sullivan Bridge				3	MR	3	S	-	P	-	L	O
Unnamed tributary of Bullhead Creek			(n=0)	U	-	-	-	-	-	-	-	-
Whitetail Creek	50	-	(n=1)	U	-	-	-	-	-	-	-	-

TETON RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Antelope Butte Swamp			(n=0)	U	-	-	-	-	-	-	-	-
Deep Creek			(n=0)	U	-	-	-	-	-	-	-	-
McDonald Creek			(n=0)	U	-	-	-	-	-	-	-	-
NF Deep Creek			(n=0)									
Slim Gulch-BLM Bdry. Sec. 18				4	NB	0	-	-	S	S	L	0
SF Deep Creek			(n=0)									
T23N R9W Sec. 22-NF Deep Creek				4	NB	0	-	-	P	S	M	0
Spring Creek			(n=0)	U	-	-	-	-	-	-	-	-
Teton River (Headwaters-Choteau)	390	14	(n=3)									
NF & SF Teton River-Choteau/Deep Creek				3	SR	3	S	-	P	-	L	0

Column 1 = Angler days/year (average of 1982-1986 values)[a]
Column 2 = Angler days/year/river mile
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Column 4 = Recreational value—1 = outstanding; 2 = substantial; 3 = moderate; 4 = limited; U = unclassified
Column 5 = Water character—F = flat; SR = small rapids; MR = moderate rapids; LR = large rapids; NB = not boated
Column 6 = Months of year boatable
Column 7 = Boating/floating[b]
Column 8 = Boat fishing[b]
Column 9 = Shore fishing[b]
Column 10 = Shoreline activities[b]
Column 11 = Nonangler use estimate—H = high; M = moderate; L = low
Column 12 = Number of developed sites

[a] For this EIS, high angler use = more than 10,000 angler days per year for a given stream or river segment; moderate angler use = 1,000-10,000 angler days per year; low angler use = less than 1,000 angler days per year.

[b] For columns 7 through 10: P = primary activity, one of the main reasons for visiting this stream or river segment; S = secondary activity, an activity or use occurring on this stream, but not one of the most important uses

Sources: Columns 1 through 3: DFWP 1989_.
Columns 4 through 12: Natural Resource Information System 1989. Comprehensive recreation information is not available for all streams.

Teton River drainage (continued)	1	2	3	4	5	6	7	8	9	10	11	12
Teton River (Choteau-Mouth)	632	4	(n=2)									
Choteau-Hwy. 91 (I-15)				3	SR	3	S	-	P	-	L	0
Hwy. 91 (I-15)-Coulee Fork				3	F	3	S	-	S	-	L	0
Coulee Fork-Marias River				3	F	4	S	-	P	-	L	0

MUSSELSHELL RIVER DRAINAGE

STREAM	1	2	3	4	5	6	7	8	9	10	11	12
Alabaugh Creek			(n=0)									
Headwaters-Robinson Creek				4	NB	0	-	-	S	S	L	0
American Fork Creek	1,106	-	(n=4)									
Headwaters-Musselshell River				4	NB	0	-	-	P	S	L	0
Big Dry Creek			(n=0)	U	-	-	-	-	-	-	-	-
Big Elk Creek	344	-	(n=1)	U	-	-	-	-	-	-	-	-
Careless Creek			(n=0)									
Headwaters-Forest Service Boundary				3	NB	0	-	-	S	P	M	0
Checkerboard Creek	186	-	(n=2)									
Main Forks-Forest Service Boundary				4	NB	0	-	-	S	S	L	0
Cottonwood Creek	361	-	(n=3)	U	-	-	-	-	-	-	-	-
Flatwillow Creek	740	-	(n=4)									
Confluence NF & SF-Hwy 87				3	NB	0	-	-	P	S	H	0
Hwy 87-Petrolia Lake				4	NB	0	-	-	P	-	L	0
Petrolia Lake-Musselshell River				3	NB	0	-	-	P	-	L	0
Little Dry Creek			(n=0)	U	-	-	-	-	-	-	-	-
Musselshell River (Headwaters-Lavina)	5,194	46	(n=4)	-	-	-	-	-	-	-	-	-
Musselshell River (Lavina-Mouth)	3,869	15	(n=4)									
NF & SF Confluence-Careless Creek				3	SR/MR	4	S	-	P	S	M	1
Careless Creek-Flatwillow Creek				4	F	2	S	-	P	S	L	3
Flatwillow Creek-Fort Peck Reservoir				3	F/MR	3	S	-	P	S	L	0
NF Musselshell (Headwaters-Mouth)	270	-	(n=3)	U	-	-	-	-	-	-	-	-
NF Musselshell (Bair Reservoir-SF Musselshell)				3	NB	0	-	-	P	P	M	1
SF Musselshell	281	-	(n=4)	U	-	-	-	-	-	-	-	-
Spring Creek	137	-	(n=1)									
Headwaters-NF Musselshell River				3	NB	0	-	-	P	P	H	1
Swimming Woman Creek			(n=0)									
Headwaters-Forest Service Boundary				2	NB	0	-	-	S	P	M	0

APPENDIX I

AVERAGE MONTHLY AND ANNUAL FLOWS REMAINING AFTER REQUESTED INSTREAM FLOWS ARE SUBTRACTED

Table I-1. Average monthly and annual flow (cfs) remaining after requested instream flows are subtracted

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
GALLATIN RIVER DRAINAGE													
Baker Creek near Manhattan	86	96	81	70	74	86	126	266	396	126	46	73	127
Ben Hart Creek near Belgrade	2	2	1	1	0	1	2	5	6	5	3	2	3
Big Bear Creek near Gallatin Gateway	4	3	2	2	1	2	6	36	60	22	8	5	13
Bridger Creek near Bozeman	0	0	0	0	0	0	44	142	82	20	0	0	24
Cache Creek at mouth near West Yellowstone	1.4	1.4	0.4	0.4	0.4	0.4	7.4	42.4	41.4	11.4	3.4	2.4	9
East Fork Hyalite Creek near Bozeman	0	0	0	0	0	0	1	24	54	23	2	1	9
East Gallatin River at Bozeman	11	8	4	0	1	17	127	227	157	31	6	9	50
East Gallatin River near Belgrade	0	0	0	0	0	0	100	280	240	20	0	0	53
East Gallatin River near Manhattan	20	10	0	0	0	10	90	610	730	240	60	30	150
Gallatin River near Logan	70	0	0	0	0	0	90	1400	2700	1000	220	120	467
Gallatin River near Gallatin Gateway	303	353	263	183	213	313	563	1663	2663	563	0	203	607
Hellroaring Creek near Gallatin Gateway	9	4	1	0	0	0	22	134	164	57	17	11	35
Hyalite Creek above interstate near Bozeman	0	0	0	0	0	0	6	69	94	25	4	0	17
Hyalite Creek at Hyalite Reservoir near Bozeman	11	0	0	0	0	0	11	112	192	102	50	22	42
Middle Fork West Fork Gallatin River near Gallatin Gateway	6	4	3	2	2	2	12	63	91	33	10	7	20
Porcupine Creek near Gallatin Gateway	3.5	2.5	0.5	0.5	0.5	0	12.5	68.5	89.5	32.5	9.5	4.5	19
Reese Creek near Belgrade	3	4	3	2	2	3	8	37	45	11	4	3	10
Rocky Creek near Bozeman	0	0	0	0	0	0	0	59	36	0	0	0	8
Sourdough Creek near Bozeman	0	0	0	0	0	0	0	33.1	40.1	0	0	0	6
South Cottonwood Creek near Gallatin Gateway	6	2	0	0	0	0	6	59	106	43	12	7	20
South Fork Spanish Creek near Gallatin Gateway	3	0	0	0	0	0	16	135	175	57	12	6	34
South Fork West Fork Gallatin River near Gallatin Gateway	16	10	7	6	5	5	36	185	285	92	26	19	58
Spanish Creek near Gallatin Gateway	0	0	0	0	0	0	0	170	250	60	0	0	40
Squaw Creek near Gallatin Gateway	7	5	2	1	2	3	18	88	108	34	12	8	24
Taylor Creek near Grayling	0	0	0	0	0	0	0	194	384	164	32	6	65
Thompson Creek near Belgrade	4	3	0	1	0	0	4	8	8	6	3	3	3
West Fork Gallatin River near Gallatin Gateway	13	3	0	0	0	0	44	294	434	144	30	18	82
West Fork Hyalite Creek near Bozeman	1	0	0	0	0	0	1	44	88	50	6	2	16
MADISON RIVER DRAINAGE													
Antelope Creek at mouth near Cameron	0	0	0	0	0	0	2	36	38	4	5	3	7
Beaver Creek near West Yellowstone	9	4	0	0	0	0	33	218	278	108	32	15	58
Blaine Spring Creek near Cameron	4	2	0	0	0	0	3	15	22	15	7	3	6
Cabin Creek near West Yellowstone	0	0	0	0	0	0	11	158	278	78	1	0	44
Cherry Creek near Norris	11	7	2	0	3	5	28	135	155	62	21	14	37
Cougar Creek near West Yellowstone	0	0	0	0	0	0	17	146	206	49	0	0	35
Duck Creek near west Yellowstone	4	0	0	0	0	0	18	117	127	38	12	7	27
Elk River at mouth near Cameron	0	0	0	0	0	0	21	192	202	45	2	0	39
Grayling Creek near West Yellowstone	0	0	0	0	0	0	27	266	396	136	16	0	70
Hot Springs Creek near Norris	2.5	1.5	0	0	0	0.5	8.5	35.5	39.5	14.5	6.5	3.5	9
Indian Creek near Cameron	0	0	0	0	0	0	10	212	282	92	5	0	50
Jack Creek near Ennis	0	0	0	0	0	0	1	74	126	47	10	3	22
Madison River below Ennis Lake near McAllister	1184	1284	784	684	684	684	884	1184	2284	1184	884	984	1059
Madison River below Hebgen Lake near Grayling	796	896	466	386	316	306	416	226	696	496	596	696	524
Madison River near Three Forks	1111	1011	811	511	511	611	711	1111	2211	1011	611	711	911
Madison River near West Yellowstone	196	176	176	166	166	166	236	586	606	286	196	186	262
Moore Creek at Ennis	0	0	0	0	0	0	2.6	10.6	12.6	2.6	0.6	0	2
North Fork Meadow Creek at Forest Service boundary near Ennis	0	0	0	0	0	0	1	70	92	40	11	0	18
O'Dell Creek near Ennis	12	2	2	1	0	0	12	52	62	42	22	12	18

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Red Canyon Creek near West Yellowstone	0	0	0	0	0	0	2.1	18.1	28.1	5.1	0	0	4
Ruby Creek near Cameron	0	0	0	0	0	0	0	9	16	0	0	0	2
South Fork Madison River near West Yellowstone	18	8	3	1	0	1	18	128	188	98	38	28	44
Squaw Creek near Cameron	0	0	0	0	0	0	1	45	59	14	0	0	10
Standard Creek near Cameron	0	0	0	0	0	0	2	38	51	21	3	0	10
Trapper Creek near West Yellowstone	0	0	0	0	0	0	2.8	18.8	24.8	5.8	0.8	0	4
Watkins Creek near West Yellowstone	0	0	0	0	0	0	3.5	32.5	47.5	12.5	0	0	8
West Fork Madison River near Cameron	12	6	0	0	0	3	42	208	238	98	27	14	54
JEFFERSON RIVER DRAINAGE													
Black Sand Spring Creek[a]	0	0	0	0	0	0	0	0	0	0	0	0	0
Boulder River above Cabin Gulch	22	19	12	10	15	30	116	366	336	86	12	12	86
Boulder River above High Ore Creek near Basin	12	10	4	3	6	19	110	400	360	74	4	4	84
Boulder River near Cardwell	10	6	0	0	1	20	133	433	403	93	0	0	92
Halfway Creek[a]	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3
Hells Canyon Creek near Twin Bridges	0	0	0	0	0	0	3.4	18.4	23.4	7.4	1.4	0.4	5
Jefferson River near Three Forks	700	800	300	200	300	500	1600	3300	5800	1200	0	200	1242
Little Boulder River near Boulder	5	3	1	1	1	4	13	64	59	13	3	4	14
North Willow Creek at Pony	4	6	4	2	4	6	11	39	52	18	0	1	12
South Boulder River near Jefferson Island	7	3	0	0	0	0	5	32	138	59	20	11	23
South Willow Creek near Pony	3	5	1	0	0	3	17	80	116	36	0	0	22
Whitetail Creek near Whitehall	4	0	0	0	0	0	1	22	36	22	24	15	10
Willow Creek near Harrison	17	20	15	10	13	17	28	49	96	48	0	6	27
Willow Spring Creek[a]	0	0	0	0	0	0	0	0	0	0	0	0	0
BIG HOLE RIVER DRAINAGE													
American Creek at mouth near Wise River	0	0	0	0	0	0	0.2	6.2	6.2	0.2	0	0	1
Bear Creek near Wise River	0	0	0	0	0	0	1.2	14.2	15.2	3.2	0.2	0	3
Big Hole River near Jackson													

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Big Hole River near Melrose	0	0	0	0	0	0	900	3000	3800	900	0	0	717
Big Hole River near Wise River	0	0	0	0	0	0	200	1800	2400	190	0	0	383
Big Lake Creek near mouth near Wisdom	1.3	0.3	0	0	0	0.3	10.3	45.3	45.3	12.3	3.3	2.3	10
Birch Creek near Glen	6	1	0	0	0	0	2	41	100	56	18	3	19
Bryant Creek at mouth near Wise River	1.6	1.6	0.6	0.6	0.6	1.6	6.6	23.6	23.6	6.6	3.6	2.6	6
California Creek above American Creek	0	0	0	0	0	0	0	11	11	0	0	0	2
Camp Creek at Melrose	0	0	0	0	0	0	3	24	49	13	0	0	7
Canyon Creek near Divide	2	1	0	0	0	0	13	64	88	21	3	1	16
Corral Creek at mouth near Wise River	0	0	0	0	0	0	2	9	9	2	1	0	2
Deep Creek near Wise River	0	0	0	0	0	0	41	230	200	44	9	2	44
Delano Creek[a]	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1
Divide Creek at Divide	2	2	1	0	0	1	10	40	52	14	3	1	11
Fishtrap Creek at mouth near Wise River	2	0	0	0	0	0	29	190	180	28	3	0	36
Francis Creek at mouth near Wisdom	1	0	0	0	0	0	10	46	41	8	2	1	9
French Creek near mouth near Wise River	1	0	0	0	0	0	10	38	39	10	3	1	9
Govemor Creek near Jackson	17	14	11	9	9	11	47	176	166	47	21	16	45
Jacobson Creek at mouth near Wise River	2	0	0	0	0	0	22	136	146	37	8	2	29
Jerry Creek near Wise River	3	0	0	0	0	0	12	67	73	23	7	3	16
Johnson Creek near Wisdom	0	0	0	0	0	0	7	66	67	6	0	0	12
Joseph Creek at mouth near Wisdom	0	0	0	0	0	0	7	42	42	10	2	0	9
Lamarche Creek near Wise River	7	3	1	0	0	0	27	159	199	60	14	8	40
Miner Creek near Jackson	3	2	0	0	0	0	15	73	131	61	10	1	25
Moose Creek near Divide	0	0	0	0	0	0	5	30	30	5	0	0	6
Mussigbrod Creek near Wisdom	0	0	0	0	0	0	9	160	110	7	0	0	24
North Fork Big Hole River near mouth near Wisdom	17	11	3	0	0	2	110	580	520	110	25	14	116
Oregon Creek near mouth near Wise River	0.2	0.1	0	0	0	0.1	0.7	4.7	3.7	0.7	0.5	0.3	1
Pattengail Creek at mouth near Wise River	9	6	3	1	1	4	34	148	158	47	14	9	36
Pintlar Creek near Forest Service boundary near Wisdom													

Stream	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Rock Creek[a]	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	11
Ruby Creek at mouth near Wisdom	4	3	2	1	1	2	20	93	90	19	5	3	20
Sevenmile Creek at mouth near Wise River	0	0	0	0	0	0	1.2	7.2	6.2	1.2	0.2	0	1
Seymour Creek near Wise River	0	0	0	0	0	0	13	86	87	21	2	0	17
Sixmile Creek at mouth near Wise River	0	0	0	0	0	0	0.4	5.4	5.4	0.4	0	0	1
South Fork Big Hole River[a]	0	0	0	0	0	0	0	0	204	0	0	0	17
Steel Creek near mouth near Wisdom	3	1	0	0	0	0	18	76	72	16	4	2	16
Sullivan Creek at mouth near Wise River	0	0	0	0	0	0	4	28	27	6	1	0	6
Swamp Creek near mouth near Wisdom	3	0	0	0	0	0	25	152	122	24	6	3	28
Tenmile Creek at mouth near Wisdom	0.2	0	0	0	0	0	6.2	36.2	35.2	8.2	2.2	0.2	7
Trail Creek near Wisdom	8	5	2	0	0	1	59	366	266	44	12	6	64
Trapper Creek near Melrose	2.8	2.8	1.8	0.8	0.8	1.8	9.8	39.8	49.8	14.8	4.8	2.8	11
Twelvemile Creek at mouth near Wise River	1.8	1.8	0.8	0.8	0.8	0.8	5.8	27.8	26.8	7.8	3.8	1.8	7
Warm Springs Creek at Jackson	0	0	0	0	0	0	14	90	100	13	0	0	18
Willow Creek near Glen	0	0	0	0	0	0	0	21	48	14	1	0	7
Wise River near Wise River	26	14	9	3	1	5	48	495	825	225	58	34	145
Wyman Creek at mouth near Wise River	2	0	0	0	0	0	13	63	66	17	5	2	14
RUBY RIVER DRAINAGE													
Coal Creek at mouth near Alder	0	0	0	0	0	0	4.4	22.4	22.4	5.4	1.4	0.4	5
Cottonwood Creek at mouth near Alder	2	1	0	0	0	0	10	45	45	12	4	2	10
East Fork Ruby River at mouth near Alder	1	1	0	0	0	0	7	33	33	9	3	2	7
Mill Creek at Forest Service boundary near Sheridan	1	0	0	0	0	0	11	84	110	48	12	4	23
North Fork Greenhorn Creek at mouth near Alder	0	0	0	0	0	0	3.5	17.5	18.5	4.5	0.5	0	4
Ruby River above reservoir near Alder	30	30	20	10	10	20	80	340	390	110	30	20	91
Ruby River near Twin Bridges	180	180	140	110	90	130	160	210	340	200	100	170	168
Warm Springs Creek at mouth near Alder	2.5	0.5	0	0	0	0.5	16.5	72.5	76.5	20.5	5.5	2.5	16
West Fork Ruby River at mouth near Alder	2	1	1	0	0	1	9	39	39	11	4	3	9
Wisconsin Creek at Forest Service boundary near Sheridan	0	0	0	0	0	0	5	65	87	29	3	0	16

Stream	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
BEAVERHEAD RIVER AND RED ROCK RIVER DRAINAGE													
Bear Creek near Grant	0	0	0	0	0	0	3.5	26.5	24.5	3.5	0	0	5
Beaverhead River at Barretts	180	190	150	100	100	140	220	370	630	430	330	210	254
Beaverhead River near Twin Bridges	280	390	320	240	250	300	320	140	230	100	60	240	239
Big Sheep Creek below Muddy Creek near Dell	11	7	0	0	0	0	38	24	46	19	17	4	14
Black Canyon Creek near Grant	0.5	0	0	0	0	0	3.5	13.5	13.5	3.5	0.5	0.5	3
Blacktail Deer Creek near Dillon	16.5	16.5	4.5	2.5	6.5	16.5	27.5	60.5	92.5	53.5	20.5	16.5	28
Bloody Dick Creek near Grant	0	0	0	0	0	0	27	140	140	27	1	0	28
Browns Canyon Creek near Grant	0	0	0	0	0	0	2.7	16.7	15.7	3.7	0.7	0	3
Cabin Creek above Simpson Creek	0	0	0	0	0	0	0	3	4	1	0	0	1
Corral Creek near Lakeview	0	0	0	0	0	0	0	2	2	0	0	0	0
Deadman Creek near Dell	0.5	0.5	0	0	0	0.5	5.5	17.5	21.5	4.5	1.5	0.5	4
East Fork Blacktail Creek near Dillon	1	0	0	0	0	0	20	92	82	22	6	2	19
East Fork Clover Creek at mouth near Monida	0	0	0	0	0	0	0	8.6	7.6	0	0	0	1
East Fork Dyce Creek at mouth near Polaris	0	0	0	0	0	0	1.5	7.5	8.5	2.5	0.5	0	2
Frying Pan Creek near Grant	0.4	0.4	0	0	0	0.4	3.4	12.4	11.4	3.4	1.4	0.4	3
Grasshopper Creek near Dillon	10	13	4	0	1	27	48	84	114	22	2	0	27
Hellroaring Creek near Lakeview	0	0	0	0	0	0	1	56	65	22	1	0	12
Horse Prairie Creek near Grant	11	11	0	0	0	13	76	216	206	66	11	5	51
Indian Creek above Simpson Creek	0	0	0	0	0	0	1	5	6	1	0	0	1
Jones Creek near Lakeview	0	0	0	0	0	0	1	8	8	1	0	0	2
Long Creek near Lakeview	0	0	0	0	0	0	4	25	29	8	1	0	6
Medicine Lodge Creek near Grant	0	0	0	0	0	1	13	49	73	18	0	0	13
Narrows Creek at mouth near Lakeview	0	0	0	0	0	0	0.5	1.8	1.8	0.2	0.1	0	0
Odell Creek near Lakeview	0	0	0	0	0	0	4	46	53	16	2	0	10
Peet Creek at county road near Lakeview	0	0	0	0	0	0	1.5	9.5	8.5	1.5	0.5	0	2
Poindexter Slough[a]	0	0	0	0	0	0	0	0	0	0	0	0	0
Rape Creek above reservoir near Grant	0	0	0	0	0	0	0	2	2	0	0	0	0

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Red Rock Creek near Lakeview	0	0	0	0	0	0	11	83	85	28	8	3	18
Red Rock River at Red Rock	240	210	170	120	110	130	220	250	190	190	120	190	178
Red Rock River near Kennedy Ranch near Lakeview	12	12	0	0	0	12	295	325	225	65	0	0	79
Reservoir Creek at mouth near Polaris	0.5	0	0	0	0	0.5	2.5	10.5	9.5	2.5	0.5	0.5	2
Shenon Creek near mouth near Grant	0	0	0	0	0	0	1	5	6	1	0	0	1
Simpson Creek above Indian Creek	0	0	0	0	0	0	1	5	7	2	1	0	1
Tom Creek near Lakeview	0	0	0	0	0	0	1	10	13	3	0	0	2
Trapper Creek at mouth near Grant	0	0	0	0	0	0	1	5	5	1	0	0	1
West Fork Blacktail Creek near Dillon	6	6	4	3	3	6	13	27	32	11	8	5	10
West Fork Dyce Creek at mouth near Polaris	0	0	0	0	0	0	1	4	5	1	0	0	1
MISSOURI RIVER DRAINAGE—THREE FORKS TO HOLTER DAM													
Avalanche Gulch near Winston	0	0	0	0	0	0	3	17	26	2	0	0	4
Beaver Creek[a]	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaver Creek at mouth near East Helena	5.2	5.2	5.2	4.2	5.2	6.2	13.2	25.2	24.2	10.2	5.2	5.2	10
Confederate Gulch near Winston	2	1	0	0	0	0	9	47	51	16	5	3	11
Cottonwood Creek above Beartooth Ranch	0	0	0	0	0	0	3	16	15	3	1	0	3
Crow Creek near Radersburg	5	1	0	0	0	0	12	119	159	54	13	7	31
Deep Creek below North Fork near Townsend	3	2	0	0	0	1	17	74	91	25	6	3	19
Duck Creek near Townsend	0	0	0	0	0	0	2	26	28	5	0	0	5
Dry Creek near Toston	2.2	1.2	1.2	0.2	1.2	1.2	8.2	31.2	34.2	9.2	3.2	2.2	8
Missouri River near Toston	1904	2204	1304	804	1204	1504	3104	6204	9404	2504	4	904	2587
Prickly Pear Creek near Clancy	7	5	1	0	2	8	30	88	108	35	8	5	25
Prickly Pear Creek at mouth near East Helena	1	1	0	0	0	4	25	110	130	27	3	0	25
Sevenmile Creek near mouth near Helena	2	2	1	1	1	2	6	16	23	5	1	1	5
Silver Creek at interstate near Helena	0	0	4.6	3.6	4.6	9.75	10.6	10	14	3	0	0	5
Sixteenmile Creek near Toston	21	20	13	8	11	27	71	210	270	76	19	13	63
Spokane Creek near East Helena	1	0	1	0	1	2	7	25	25	6	1	1	6

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Tenmile Creek at mouth near East Helena	0	0	0	0	0	0	3	41	57	7	0	0	9
Trout Creek at mouth near East Helena	0	0	0	0	0	1	4	27	38	7	0	0	6
Willow Creek below Elkhorn Creek near Wolf Creek	0.5	0.5	0	0	0	0	6.5	32.5	39.5	6.5	0.5	0	7
MISSOURI RIVER DRAINAGE—HOLTER DAM TO BELT CREEK													
Canyon Creek below Cottonwood Creek near Canyon Creek	1	1	4	0	2	20	38	110	180	25	0	0	32
Little Prickly Pear Creek near Canyon Creek	0	0	4	0	2	21	45	98	158	21	0	0	29
Little Prickly Pear Creek near Wolf Creek	0	0	0	0	0	11	110	310	150	40	6	0	52
Lyons Creek near Wolf Creek	0	0	0	0	0	0	4	27	35	6	0	0	6
Missouri River near Ulm	700	1200	1300	1200	1200	1600	2700	3976	8325	3200	200	200	2150
Sheep Creek at mouth near Cascade	0	0	0	0	0	0	14	188	208	62	16	6	41
Stickney Creek near Craig	0	0	0	0	0	0	0	0	0	0	0	0	0
Wegner Creek near Craig	0	0	0	0	0	0	0	0	0	0	0	0	0
Wolf Creek at mouth at Wolf Creek	0	0	0	0	0	0	6	35	44	7	0	0	8
DEARBORN RIVER DRAINAGE													
Dearbom River near Craig	0	0	0	0	0	0	90	570	700	100	0	0	122
Flat Creek above Slew Creek near Craig	5.5	5.5	3.5	1.5	3.5	8.5	27.5	102.5	122.5	34.5	6.5	2.5	27
Middle Fork Dearborn River at Highway 200 near Wolf Creek	3.5	0.5	0	0	0	0.5	22.5	110.5	120.5	26.5	5.5	2.5	24
South Fork Dearborn River at Highway 434 near Wolf Creek	0	0	0	0	0	0	19.5	108.5	118.5	24.5	2.5	0	23
SMITH RIVER DRAINAGE													
Big Birch Creek at mouth near White Sulphur Springs	18	14	9	7	22	49	65	159	249	68	9	14	57
Eagle Creek near mouth near White Sulphur Springs	2.5	1.5	0.5	0	0	0	9.5	47.5	55.5	12.5	3.5	2.5	11
Hound Creek near mouth near Cascade	0	0	0	0	0	0	35	265	225	47	2	0	48
Newlan Creek below Charcoal Gulch near White Sulphur Springs	2.2	2.2	1.2	0.2	1.2	5.2	13.2	29.2	34.2	12.2	4.2	2.2	9
North Fork Smith River at Highway 89 near White Sulphur Springs	0	0	0	0	0	0	7	401	181	16	4	0	51
Rock Creek below Buffalo Canyon near White Sulphur Springs	2	0	0	0	0	0	14	77	89	24	6	2	18
Sheep Creek near mouth near White Sulphur Springs	15	9	4	1	0	1	53	304	364	94	28	17	74

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Smith River near Fort Logan	33	23	12	8	33	63	123	233	303	103	8	23	80
Smith River near Eden	20	0	0	0	0	20	270	840	950	300	10	0	201
South Fork Smith River at mouth near White Sulphur Springs	6	5	3	2	5	12	23	66	81	22	4	5	20
Tenderfoot Creek below South Fork near White Sulphur Springs	10	3	0	0	0	0	33	207	227	63	22	14	48

SUN RIVER DRAINAGE

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Elk Creek near Augusta	32	23	8	15	17	18	29	204	324	84	22	15	66
Ford Creek near Augusta	4	0	0	0	0	0	5	52	69	32	8	6	15
North Fork Willow Creek below Cutrock Creek near Augusta	0	0	0	0	0	1	3	11	14	3	0	0	3
Sun River below diversion dam near Augusta	40	30	30	20	20	40	190	810	1700	230	10	10	261
Willow Creek near Anderson Lake near Augusta	1	0	0	0	0	0	6	25	30	6	1	0	6

BELT CREEK DRAINAGE

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Belt Creek near Monarch	0	0	0	0	0	0	30	540	610	130	0	0	109
Belt Creek near Portage	11	0	0	0	0	0	105	735	1065	185	24	7	178
Big Otter Creek above Never Sweat Creek near Raynesford	0	1	1	0	2	8	9	26	28	6	2	0	7
Dry Fork at mouth at Monarch	7	4	2	0	0	1	23	103	123	35	10	7	26
Logging Creek at Logging Creek Campground near Monarch	3	1	0	0	0	0	8	39	38	12	5	4	9
Pilgrim Creek at mouth near Monarch	2	0	0	0	0	0	20	88	80	19	4	2	18
Sun River at Simms	70	80	60	60	60	40	260	970	1970	290	40	0	325
Tillinghast Creek above Joice Creek near Monarch	2	0	0	0	0	0	9	48	52	16	5	3	11

MARIAS RIVER DRAINAGE

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Badger Creek[a]	91	91	91	91	91	91	91	91	91	91	91	91	91
Birch Creek near Valier	0	0	0	0	0	96	36	30	76	0	0	0	20
Cut Bank Creek at Cut bank	2	0	0	0	0	75	165	445	525	155	2	0	114
Dupuyer Creek below Scoffin Creek near Dupuyer	0	0	1	0	0	10	27	98	118	22	0	1	23
Marias River above Tiber Reservoir near Shelby	260	200	140	80	170	510	1000	3000	3600	1000	220	200	865
Marias River near Loma	421	201	0	0	0	41	451	961	1461	861	661	441	458
North Fork Badger Creek near Browning	5	2	1	0	0	0	28	186	196	51	12	4	40
North Fork Dupuyer Creek near Dupuyer	0	0	0	0	0	0	0	40	40	4	0	0	7
South Fork Badger Creek near Browning	0	0	0	0	0	0	5	180	190	31	0	0	34
South Fork Dupuyer Creek near Dupuyer	0	0	0	0	0	0	4	33	33	7	0	0	6
South Fork Two Medicine River near East Glacier	7	7	0	0	0	0	23	324	244	47	20	11	57

TETON RIVER DRAINAGE

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Deep Creek near Choteau	0	0	0	0	0	0	1	18	25	2	0	0	4
McDonald Creek near Strabane	1	1	0	0	0	2	4	6	6	3	1	1	2
North Fork Deep Creek near Choteau	0	0	0	0	0	0	8.8	57.8	58.8	13.8	2.8	0	12
South Fork Deep Creek near Choteau	0.1	0	0	0	0	0	8.1	55.1	56.1	13.1	2.1	0.1	11
Teton River near Strabane	0	0	0	0	0	0	0	52	65	26	0	0	12

MISSOURI RIVER DRAINAGE—BELT CREEK TO FORT PECK RESERVOIR

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Cow Creek below Forks near Cleveland	0.5	0	0	0	0	0	4.5	18.5	25.5	7.5	2.5	0.5	5
Highwood Creek below Smith Creek near Highwood	0	0	0	0	0	0	11	75	78	15	2	0	15
Missouri River at Fort Benton	1900	2300	2200	2100	2400	2306	3013	2315	5716	2604	900	1500	2438
Missouri River near Landusky	2100	2400	2200	2000	2600	3000	2900	6849	6698	3824	1000	1700	3106
Shonkin Creek below Bishop Creek near Highwood	0	0	0	0	0	0	11	74	63	11	3	1	14

JUDITH RIVER DRAINAGE

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Beaver Creek at county road near Lewistown	2	4	4	3	10	42	28	50	51	13	5	2	18
Big Spring Creek above Cottonwood Creek	76	66	56	56	56	56	136	276	226	136	106	86	111
Big Spring Creek at mouth near Lewistown	76	56	44	38	40	56	196	656	486	216	126	96	174
Cottonwood Creek at Highway 200 near Lewistown	1.5	0	0	0	0	0	9.5	70.5	82.5	18.5	3.5	2.5	16
East Fork Big Spring Creek at mouth near Lewistown	1.5	0.5	0	0	0	0.5	19.5	90.5	88.5	22.5	5.5	2.5	19
Judith River above Courtneys Creek at Utica	0	0	0	0	0	0	14	145	185	42	0	0	32
Judith River near Winifred	250	260	260	270	320	380	360	380	390	390	310	280	321
Lost Creek at mouth near Utica	0	0	0	0	0	0	9	69	72	15	0	0	14

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Middle Fork Judith River near Utica	0	0	0	0	0	0	0	109	229	48	0	0	32
Missouri River at Virgelle	1600	1900	1700	1600	1900	1700	2000	4849	4698	1824	400	1200	2114
South Fork Judith River at Indian Hill Campground near Utica	0	0	0	0	0	0	5.5	33.5	44.5	6.5	0.5	0.5	8
Warm Springs Creek above Meadow Creek near Hilger	0	0	0	0	0	0	0	0	0	0	0	0	0
Yogo Creek at mouth near Utica	0	0	0	0	0	0	6	25	38	7	0	0	6
MUSSELSHELL RIVER DRAINAGE													
Alabaugh Creek at mouth near Lennep	0	0	0	0	0	0	0	35	42	3	0	0	7
American Fork near Harlowton	0	0	0	0	0	0	0	1.5	50.5	0	0	0	4
Big Elk Creek at mouth at Twodot	0	0	0	0	0	0	5.5	33.5	52.5	5.5	0	0	8
Careless Creek below Little Careless Creek near Hedgesville	0	0	0	0	0	11	7	13	13	1	0	0	4
Checkerboard Creek near Checkerboard	0	0	0	0	0	0	0	16	19	1	0	0	3
Collar Gulch Creek[a]	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1
Cottonwood Creek below Loco Creek near Martinsdale	0	0	0	0	0	0	22	182	202	47	11	4	39

Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
Flatwillow Creek below the forks near Grass Range	0	0	0	0	0	0	18	115	205	36	0	0	31
Musselshell River at Harlowton	0	1	0	0	0	30	90	310	430	90	3	0	80
Musselshell River near Mosby	12	17	12	16	150	480	280	560	930	280	50	60	237
Musselshell River near Roundup	0	0	0	0	30	140	120	360	640	210	90	40	136
North Fork Musselshell River near Delpine	4	4	3	3	3	6	16	23	26	12	6	5	9
North Fork Musselshell River near mouth near Martinsdale	0	0	0	0	0	0	11	54	62	9	0	0	11
South Fork Musselshell River above Martinsdale	1	0	0	0	0	7	80	290	310	48	0	0	61
Spring Creek below Whitetail Creek near Checkerboard	0	0	0	0	0	0	10	79	60	13	2	0	14
Swimming Woman Creek below Dry Coulee	0	0	0	0	0	0	1.5	12.5	16.5	2.5	0	0	3
FORT PECK RESERVOIR DRAINAGE													
Little Dry Creek near Van Norman	0	0	0	0	0	0	0	0	30.5	22.5	5.5	6.5	5
Big Dry Creek near Van Norman	0	0	0	0	0	0	0	0	71.5	51.5	10.5	13.5	12

[a] Streamflow values from USGS 1989

APPENDIX J

PROJECTS WHICH HAVE THE POTENTIAL TO INCREASE ARSENIC CONCENTRATIONS IN SURFACE AND GROUNDWATER

Table J-1. Projects that would divert water directly from the mainstem Missouri/Madison rivers and could increase arsenic concentrations in surface water and groundwater

Subbasin/Drainage	Consumptive Use	Instream	Combination
Headwaters Subbasin			
Madison River	GA-201	-0-	GA-201
Upper Missouri Subbasin			
Missouri River	BR-11	BR-11	BR-11
(Three Forks to Holter Dam)	BR-12	BR-12	BR-12
	BR-108	BR-108	BR-108
	BR-103	BR-14	BR-14
	BR-14	BR-106	BR-106
	BR-106	BR-107	BR-107
	BR-107	BR-5	BR-5
	BR-5	BR-109	BR-109
	BR-109	BR-110	BR-110
	BR-110	BR-50	BR-50
	BR-104	BR-34	BR-38
	BR-50	BR-38	
	BR-34		
	BR-111		
	BR-38		
Missouri River	CS-541	CS-541	CS-541
(Holter Dam to Belt Creek)	CS-101	CS-101	CS-101
	CS-102	CS-102	CS-102
	CS-103	CS-103	CS-103
	CS-111	CS-111	CS-111
	CSI-101	CSI-101	CSI-101
	CSI-22	CSI-22	CSI-22
	CSI-52	CSI-52	CSI-52
	CSI-11	CSI-11	CSI-11
	CSI-51	CSI-51	CSI-51
	CSI-35	CS-351	CSI-35
	CS-35	CSI-21	CS-351
	CSI-21	CSI-12	CSI-21
	CSI-34	CSI-41	CSI-34
	CSI-23	LC-210	CSI-23
	CSI-12		CSI-12
	CSI-41		CSI-41
	CSI-31		CSI-31
	CSI-33		CSI-33
	CSI-32		CSI-32
	LC-210		LC-210
Middle Missouri Subbasin			
Missouri River	FEI-10	FEI-10	FEI-10
(Belt Creek to Fort Peck	CHI-21	CHI-21	CHI-21
Reservoir)	CH-21	CH-21	CH-21
	CHI-22	CHI-22	CHI-22
	CHI-30	CHI-30	CHI-30
	CHI-40	CHI-40	CHI-40
	CHS-3	CHI-10	CHS-3
	CHI-10		CHI-10
	CHS-5		CHS-5
	CH-211		CH-211
	CH-511		CH-511
	FEI-30		FEI-30
	FEI-20		BUREC
	CH-371		
	CHS-6		
	BUREC		
Fort Peck Reservoir and Small Tributaries	VAS-1	VAS-1	VAS-1

Table J-2. Projects that would increase arsenic concentrations in the Missouri River by reducing dilution flows

Subbasin/Drainage	Consumptive Use	Instream	Combination
Headwaters Subbasin			
Gallatin River	GA-40	-0-	GA-41
	GA-81		GA-79
	GA-41		GA-24
	GA-79		GA-46
	GA-24		GA-143
	GA-46		GA-44
	GA-13		GA-151
	GA-143		GA-124
	GA-44		GA-14
	GA-151		GA-35
	GA-124		GA-92
	GA-110		
	GA-130		
	GA-14		
	GA-35		
	GA-92		
Madison River	GA-201	-0-	GA-201
Jefferson River	BR-52	-0-	BR-52
	BR-101		BR-101
	GA-102		BR-102
	JV-203		JV-55
	JV-55		
	JV-95		
	JV-204		
	JV-202		
	JV-25		
Boulder River	JV-18	-0-	JV-18
	JV-80		JV-80
	JV-17		JV-17
	JV-81		JV-81
	JV-63		JV-63
Upper Missouri Subbasin			
MissouriRiver -Three Forks to Holter Dam	BR-11	BR-11	BR-11
	BR-12	BR-12	BR-12
	BR-108	BR-108	BR-108
	BR-103	BR-14	BR-103
	BR-14	BR-106	BR-14
	BR-106	BR-107	BR-106
	BR-107	BR-5	BR-107
	BR-5	BR-109	BR-5
	BR-109	BR-110	BR-109
	BR-110	BR-50	BR-110
	BR-104	BR-34	BR-50
	BR-50	BR-38	BR-38
	LC-11	BR-44	BR-44
	BR-34	BR-40	BR-40
	BR-111	BR-41	BR-41
	BR-38	BR-42	BR-42
	BR-44	BR-28	BR-28
	BR-40	BR-35	BR-35
	BR-41	LCI-10	LCI-10
	BR-42		
	BR-28		
	BR-29		
	BR-35		
	LCI-10		

Subbasin/Drainage	Consumptive Use	Instream	Combination
Missouri River - Holter Dam to Belt Creek	CS-541	CS-541	CS-541
	CS-101	CS-101	CS-101
	CS-102	CS-102	CS-102
	CSI-103	CSI-103	CSI-103
	CS-111	CS-111	CS-111
	CSI-101	CSI-101	CSI-101
	CSI-22	CSI-22	CSI-22
	CSI-52	CSI-52	CSI-52
	CSI-11	CSI-11	CSI-11
	CSI-51	CSI-51	CSI-51
	CSI-35	CS-351	CSI-35
	CS-351	CSI-21	CS-351
	CSI-21	CSI-12	CSI-21
	CSI-34	CSI-41	CSI-34
	CSI-23	LC-210	CSI-23
	CSI-12		CSI-12
	CSI-41		CSI-41
	CSI-31		CSI-31
	CSI-33		CSI-33
	CSI-32		CSI-32
	LC-210		LC-210
Dearborn River	LCI-20	-0-	LCI-20
Smith River	CS-61	CS-61	CS-61
	CSI-102	CSI-102	CSI-102
	CS-271	CS-271	CS-271
	CS-252	CSI-111	CS-252
	CS-331	CS-331	CS-331
	CS-251	CS-251	CS-251
	CS-71		CS-71
	CSI-111		CSI-111
	MEI-12		CSI-120
	CSI-120		CS-63
	MEI-11		CS-62
	CSI-120		CS-64
	MEI-11		
	MEI-20		
	CS-63		
	CS-62		
	CS-64		
Sun River	TEI-80	CS-241	CSI-83
	CS-241	CSI-83	CSI-81
	CSI-83	CSI-82	CSI-82
	CS-52	CSI-92	CSI-92
	CSI-81	TE-571	CSI-91
	CSI-82		TE-181
	CSI-71		TE-183
	TEI-100		LC-131
	CS-171		TE-571
	CS-471		
	CSI-92		
	TEI-90		
	CSI-91		
	CS-31		
	CS-51		
	CS-32		
	CSS-200		
	CS-231		
	TE-181		
	TE-183		
	CS-21		
	LC-131		
	TE-571		
	LC-251		

Subbasin/Drainage	Consumptive Use	Instream	Combination
Belt Creek	CS-43	CS-43	CS-43
	CS-42	JB-281	CS-42
	CS-44		CS-44
	CS-159		CS-159
	CHI-1		JB-281
	JB-281		JB-61
	JB-61		
Marias/Teton Subbasin			
Marias River	CHI-53	CHI-53	CHI-53
	CHI-51	CHI-51	CHI-51
	LI-161	LI-161	LI-161
	LI-162	LI-162	LI-162
	LI-263	GL-221	LI-263
	TO-221	GL-11	TO-221
	CHI-52		CHI-52
	LI-262		LI-262
	BS-32		BS-32
	LI-261		LI-261
	BSS-2		LI-91
	BS-31		HI-269
	LI-91		PO-171
	HI-269		PO-251
	PO-171		POI-10
	PO-251		PO-421
	POI-10		TO-341
	PO-421		GL-221
	TO-341		GL-11
	TO-342		PO-411
	TO-211		PO-271
	GL-2121		GL-201
	GL-11		PO-211
	PO-411		TO-421
	PO-271		
	GL-201		
	PO-211		
	TO-421		
	PO-91		
Teton River	CHI-61	TE-321	TE-321
	TE-321	CH-641	CH-641
	CHI-72	TE-101	TE-101
	TEI-40	TE-591	TE-591
	TEI-30		
	CHI-74		
	TEI-10		
	TEI-50		
	TE-411		
	TEI-60		
	CHI-80		
	TEI-20		
	TE-281		
	TE-282		
	TEI-70		
	CH-381		
	CH-641		
	TE-101		
	TE-81		
	TE-581		
	TE-591		
	TE-401		
	TE-361		
	CH-381		

Subbasin/Drainage	Consumptive Use	Instream	Combination
Middle Missouri Subbasin			
Missouri River - Belt Creek to Fort Peck Reservoir	FEI-10	FEI-10	FEI-10
	CHI-21	CHI-21	CHI-21
	CH-21	CH-21	CH-21
	CHI-22	CHI-22	CHI-22
	CHI-30	CHI-30	CHI-30
	CHI-40	CHI-40	CHI-40
	CHS-3	CHI-10	CHS-3
	CHI-10	CH-551	CHI-10
	CHS-5	CH-201	CHS-5
	CH-211	CHFG-181	CH-211
	CH-511		CH-511
	FEI-39		FEI-30
	FEI-29		BUREC
	CH-321		CH-551
	CHS-6		CH-201
	BUREC		CH-541
	CH-551		CHFG-181
	CH-201		
	CH-541		
	CHFG-181		
Judith River	FEI-50	JBS-3	JBS-3
	FE-41	FE-141	JB-261
	JBI-2	FE-431	FE-401
	FE-42	FE-671	FE-141
	FE-81	FE-672	FE-161
	JBS-3	FE-673	FEI-40
	JB-261	JB-231	FE-431
	FE-111	JB-232	FE-671
	FE-401		FE-672
	FE-141		FE-673
	FE-161		JB-21
	FE-561		JB-231
	FEI-40		JB-232
	FE-431		JB-111
	FE-671		
	FE-672		
	FE-673		
	JB-21		
	JB-231		
	JB-232		
	JB-111		
	JB-309		
Musselshell River	LM-20	-0-	-0-
Fort Peck Drainage and Small Tributaries	VAS-1	VAS-1	VAS-1

APPENDIX K

ECONOMIC AND FINANCIAL ANALYSIS

Table K-1 shows the basinwide averages of the value of an acre-foot of water for recreation derived by Duffield et al (1990). A change in flow will have a greater impact on some streams and a smaller impact on others. Table K-2 shows the value of an acre foot of water originating in each subbasin for hydropower production. Table K-3 shows streams with instream requests and no consumptive requests. No other new uses have been identified on these streams. The third column of Table K-3 shows DFWP's fisheries value class rating for each stream. Water in Class 1 and Class 2 streams is likely to be more valuable than the average shown in Table K-3. Water in Class 4 and Class 5 streams is likely to be less valuable than the average shown in Table K-3.

Tables K-4 and K-5 show projects on streams with both instream and consumptive reservation requests. The fourth column in each table shows the value of an acre-foot of water in the proposed use. The value for municipal use is explained later in this appendix. The value for irrigation is derived from DNRC's economic and financial analysis of irrigation projects described in Tubbs, et al (1989). It is the median annual net return divided by the number of acre-feet used by the project. The value for instream requests is the sum of the values for recreation and power production. The value for power production is based on the hydropower losses reported in Chapter 6. The value for recreation is the year-round average of the values from Duffield, et al. (1990) shown in Table K-1. It is one-sixth of the July-August value plus five-sixths of the Rest-of-Year value. These instream values are basinwide averages. An acre-foot will be more valuable in some streams and less valuable in others. Streams that are fisheries Class 1 or 2 are likely to have higher than average values. Streams that are fisheries Class 4, 5, or 6 are likely to have lower than average values. Fisheries value classes for streams with instream requests are shown in the fifth column of Table K-5. The value for irrigation is derived from DNRC's economic and financial analysis of irrigation projects. It is the median annual net return divided by the number of acre-feet used by the project.

The fifth column in Table K-4 shows the value the requested water would have if left in the stream. For municipal requests, it is the same as the value for an instream request in the same location. Irrigation does not withdraw water in the winter. For irrigation requests, it is the simple average of the July-August value and the Rest-of-Year value.

The sixth column in Table K-4 shows the difference between the value in its proposed use and the value of the water left in the stream. For consumptive uses with a higher value than instream use this difference is positive; for consumptive uses with a lower value than instream use this difference is negative.

Table K-6 shows the size of each municipal request in thousand gallons per year, the annual cost attributable to the reservation and the cost per thousand gallons. Municipal use consists of a variety of different uses. The lowest valued municipal use is probably watering lawns. People begin to curtail lawn watering at rates of about \$2.50 per thousand gallons. The costs for Conrad, Fairfield, Power and Shelby are all above \$2.00 per thousand gallons. The value of water for other uses, such as in cooking, are much higher.

Table K-7 shows characteristics of municipal water systems where reservation requests have been received.

Table K-1. Recreation values per acre-foot at 1989 flows

Subbasin	July and August	Rest of Year
Headwaters	\$35.40	\$8.23
Upper Missouri	\$19.46	\$4.76
Marias/Teton	\$ 5.81	\$1.63
Middle Missouri	\$ 5.81	\$1.63

Source: Duffield et al. (1990)

Table K-2. Hydropower values per acre foot

Subbasin	Value
Headwaters	\$69.16
Upper Missouri	
above Canyon Ferry	\$65.16
below Canyon Ferry	\$59.07
Marias/Teton	\$30.38
Middle Missouri	\$30.38

Table K-3. Reservation requests for instream flows on streams with no competing requests

APPLICANT	STREAM	FISHERIES VALUE CLASS[c]
GALLATIN RIVER DRAINAGE		
DFWP	Baker Creek	2
DFWP	Big Bear Creek	a
DFWP	Bridger Creek	4
DFWP	Cache Creek	4
DFWP	East Fork Hyalite Creek	2
DFWP	Gallatin River #1	2
DFWP	Hell Roaring Creek	a
DFWP	Hyalite Creek #1	3[b]
DFWP	Middle Fork West Fork Gallatin River	4
DFWP	Porcupine Creek	4
DFWP	Reese Creek	2
DFWP	Rocky Creek	2
DFWP	South Cottonwood Creek	6
DFWP	South Fork Spanish Creek	4
DFWP	South Fork West Fork Gallatin River	4
DFWP	Spanish Creek	1
DFWP	Squaw Creek	1
DFWP	Taylor Fork	3
DFWP	West Fork Gallatin River	1
DFWP	West Fork Hyalite Creek	2
MADISON RIVER DRAINAGE		
DFWP	Madison River #1	1
DFWP	Black Sand Spring Creek	2
DFWP	Cougar Creek	3
DFWP	Duck Creek	3
DFWP	Grayling Creek	a
DFWP	Red Canyon Creek	a
DFWP	Watkins Creek	a
DFWP	Trapper Creek	a
DFWP	Cabin Creek	4
DFWP	Beaver Creek	4
DFWP	Antelope Creek	2
DFWP	Elk River	4
DFWP	West Fork Madison River	3
DFWP	Standard Creek	4
DFWP	Squaw Creek	4
DFWP	Ruby Creek	3
DFWP	Indian Creek	4
DFWP	Blaine Spring Creek	2
DFWP	O'Dell Spring Creek	a
DFWP	Jack Creek	3
DFWP	Moore Creek	2[b]
DFWP	North Meadow Creek	3
DFWP	Hot Springs Creek	4
DFWP	Cherry Creek	4
JEFFERSON AND BOULDER RIVER DRAINAGES		
DFWP	Boulder River #1	4
DFWP	Hells Canyon Creek	2[b]
DFWP	Willow Spring Creek	2
DFWP	Halfway Creek	1[b]
DFWP	Whitetail Creek	4
DFWP	South Boulder River	3[b]
DFWP	South Willow Creek	3
DFWP	North Willow Creek	3
DFWP	Willow Creek	2
DFWP	Little Boulder River	4
BIG HOLE RIVER DRAINAGE		
DFWP	South Fork Big Hole River	a
DFWP	Big Hole River #1	1
DFWP	Big Hole River #2	1
DFWP	Big Hole River #3	1
DFWP	Warm Springs Creek	3
DFWP	Miner Creek	1
DFWP	Rock Creek	1
DFWP	Big Lake Creek	1
DFWP	Francis Creek	2
DFWP	Steel Creek	1
DFWP	Swamp Creek	1
DFWP	Joseph Creek	3
DFWP	Trail Creek	3
DFWP	Ruby Creek	3
DFWP	Johnson Creek	3
DFWP	Mussigbrod Creek	2
DFWP	North Fork Big Hole River	1
DFWP	Pintlar Creek	3[b]
DFWP	Fishtrap Creek	3[b]
DFWP	LaMarche Creek	3
DFWP	Seymour Creek	3
DFWP	Sullivan Creek	a
DFWP	Twelvemile Creek	a
DFWP	Corral Creek	3
DFWP	Tenmile Creek	a
DFWP	Sevenmile Creek	a
DFWP	Sixmile Creek	a
DFWP	Oregon Creek	a
DFWP	California Creek	a
DFWP	American Creek	a
DFWP	French Creek	4
DFWP	Governor Creek	1
DFWP	Deep Creek	3
DFWP	Bear Creek	3
DFWP	Bryant Creek	a
DFWP	Jacobsen Creek	a
DFWP	Wyman Creek	4
DFWP	Pattengail Creek	3
DFWP	Wise River	3
DFWP	Delano Creek	a
DFWP	Jerry Creek	4
DFWP	Divide Creek	3
DFWP	Canyon Creek	3
DFWP	Moose Creek	3
DFWP	Trapper Creek	4
DFWP	Camp Creek	4
DFWP	Willow Creek	3

Table K-3 (continued)

APPLICANT	STREAM	FISHERIES VALUE CLASS[c]
DFWP	Birch Creek	4
BLM	Deep Creek	3
BLM	Bear Creek	3
BLM	Canyon Creek	3
BLM	Moose Creek	3
BLM	Camp Creek	4
BLM	Willow Creek	3
RUBY RIVER DRAINAGE		
DFWP	Ruby River #1	3[b]
DFWP	Ruby River #2	2
DFWP	Coal Creek	[a]
DFWP	Middle Fork Ruby River	[a]
DFWP	East Fork Ruby River	4
DFWP	West Fork Ruby River	4
DFWP	Cottonwood Creek	3[b]
DFWP	Warm Spring Creek	3[b]
DFWP	North Fork Greenhorn Creek	1
DFWP	Mill Creek	4
DFWP	Wisconsin Creek	5
BLM	North Fork Greenhorn Creek	1
BEAVERHEAD RIVER DRAINAGE		
DFWP	Beaverhead River #1	1
DFWP	Red Rock River #1	2[b]
DFWP	Red Rock River #2	2[b]
DFWP	Red Rock Creek	1[b]
DFWP	Hell Roaring Creek	1[b]
DFWP	Corral Creek	2
DFWP	Tom Creek	3
DFWP	Narrows Creek	2
DFWP	Odell Creek	2
DFWP	Jones Creek	3
DFWP	Peet Creek	2
DFWP	Long Creek	3
DFWP	East Fork Clover Creek	4
DFWP	Indian Creek	2
DFWP	Cabin Creek	2
DFWP	Simpson Creek	2
DFWP	Deadman Creek	3
DFWP	Big Sheep Creek	2[b]
DFWP	Black Canyon Creek	[a]
DFWP	Shenon Creek	4
DFWP	Frying Pan Creek	[a]
DFWP	Trapper Creek	[a]
DFWP	Bear Creek	2
DFWP	Rape Creek	1
DFWP	Bloody Dick Creek	3
DFWP	Browns Canyon Creek	[a]
DFWP	Medicine Lodge Creek	3
DFWP	Horse Prairie Creek	3[b]
DFWP	East Fork Dyce Creek	[a]
DFWP	West Fork Dyce Creek	[a]
DFWP	Reservoir Creek	[a]
DFWP	Grasshopper Creek	4
DFWP	Poindexter Slough	1
DFWP	East Fork Blacktail Deer Creek	3[b]
DFWP	West Fork Blacktail Deer Creek	4
DFWP	Blacktail Deer Creek	3[b]
BLM	Hell Roaring Creek	1
BLM	Corral Creek	2
BLM	Tom Creek	3
BLM	Odell Creek	2
BLM	Jones Creek	3
BLM	Peet Creek	2
BLM	Long Creek	3
BLM	Indian Creek	2
BLM	Cabin Creek	2
BLM	Simpson Creek	2
BLM	Deadman Creek	2
BLM	Big Sheep Creek	2[b]
BLM	Black Canyon Creek	[a]
BLM	Frying Pan Creek	[a]
BLM	Trapper Creek	[a]
BLM	Bear Creek	2
BLM	Rape Creek	1
BLM	Bloody Dick Creek	3
BLM	Medicine Lodge Creek	3
BLM	East Fork Dyce Creek	[a]
BLM	West Fork Dyce Creek	[a]
BLM	East Fork Blacktail Deer Creek	3[b]
BLM	West Fork Blacktail Deer Creek	4[b]
BLM	Shenon Creek	4
BLM	Trapper Creek	[a]
MISSOURI RIVER DRAINAGE - THREE FORKS TO HOLTER DAM		
DFWP	Avalanche Creek	4
DFWP	Beaver Creek	3
DFWP	Confederate Gulch	4
DFWP	Crow	
DFWP	Dry Creek	3[b]
DFWP	Duck Creek	4
DFWP	Sixteen Mile Creek	3
DFWP	Cottonwood Creek	4
DFWP	Willow Creek	3
DFWP	Beaver Creek	3[b]
DFWP	Prickly Pear Creek	2[b]
DFWP	Tenmile Creek	4[a]
DFWP	Sevenmile Creek	4
DFWP	Silver Creek	3
DFWP	Trout Creek	3
DFWP	McGuire Creek	[a]
MISSOURI RIVER DRAINAGE - HOLTER DAM TO BELT CREEK		
DFWP	Sheep Creek	3
DFWP	Spokane Creek	3
DFWP	Virginia Creek	4
DFWP	Canyon Creek	4

Table K-3 (continued)

APPLICANT	STREAM	FISHERIES VALUE CLASS[c]
DFWP	Little Prickly Pear Creek #1	2
DFWP	Little Prickly Pear Creek #2	2
DFWP	Lyons Creek	2
DFWP	Wolf Creek	3
DFWP	Wegner Creek	[a]
DFWP	Stickney Creek	3
DEARBORN RIVER DRAINAGE		
DFWP	Middle Fork Dearborn River	4
DFWP	South Fork Dearborn River	4
DFWP	Flat Creek	4
DFWP	Bean Lake	NA
SMITH RIVER DRAINAGE		
DFWP	South Fork Smith River	[a]
DFWP	North Fork Smith River	[a]
DFWP	Newlan Creek	4
DFWP	Big Birch Creek	4
DFWP	Sheep Creek	2[b]
DFWP	Eagle Creek	4
DFWP	Rock Creek	3
DFWP	Tenderfoot Creek	3
DFWP	North Fork Deep Creek	[a]
SUN RIVER DRAINAGE		
DFWP	North Fork Willow Creek	[a]
DFWP	Willow Creek	4
DFWP	Ford Creek	4
DFWP	Elk Creek	3
BELT CREEK DRAINAGE		
DFWP	Belt Creek #1	3
DFWP	Dry Fork Belt Creek	3
DFWP	Tillinghast Creek	3
DFWP	Pilgrim Creek	2
DFWP	Logging Creek	4
MARIAS RIVER DRAINAGE		
DFWP	South Fork Dupuyer Creek	2
DFWP	North Fork Dupuyer Creek	3
DFWP	Dupuyer Creek	4
DFWP	South Badger Creek	3
DFWP	North Badger Creek	1[b]
DFWP	Badger Creek	3
DFWP	South Fork Two Medicine River	2

APPLICANT	STREAM	FISHERIES VALUE CLASS[c]
TETON RIVER DRAINAGE		
DFWP	McDonald Creek	4
DFWP	South Fork Deep Creek	4
DFWP	North Fork Deep Creek	2
DFWP	Deep Creek	4
DFWP	Spring Creek	3
DFWP	Antelope Butte Swamp	NA
MISSOURI RIVER DRAINAGE - BELT CREEK TO FORT PECK DAM		
DFWP	Cow Creek	6
JUDITH RIVER DRAINAGE		
DFWP	Middle Fork Judith River	[a]
DFWP	Beaver Creek	4
DFWP	Cottonwood Creek	4
DFWP	Lost Fork Judith River	6
DFWP	Yogo Creek	4
DFWP	South Fork Judith River	6
MUSSELSHELL RIVER DRAINAGE		
DFWP	Musselshell River #1	6
DFWP	South Fork Musselshell River	4
DFWP	Alabaugh Creek	4
DFWP	Cottonwood Creek	4
DFWP	North Fork Musselshell River #1	3
DFWP	North Fork Musselshell River #2	3
DFWP	Checkerboard Creek	4
DFWP	Spring Creek	4
DFWP	Big Elk Creek	4
DFWP	American Fork Creek	4
DFWP	Careless Creek	[a]
DFWP	Swimming Woman Creek	[a]
DFWP	Collar Gulch Creek	[a]
DFWP	Flatwillow Creek	4
FORT PECK RESERVOIR DRAINAGE		
DFWP	Big Dry Creek	3[b]
DFWP	Little Dry Creek	[a]

[a] some or all reaches unclassified
[b] some reaches have lower classification
[c] 1 = outstanding fisheries resource
2 = high value fisheries resource
3 = substantial fisheries resource
4 = moderate fisheries resource
5 = limited fisheries resource
6 = unrated

Table K-4. Comparison of water values for consumptive use and instream use

STREAM	APPLICATION	PURPOSE	A CONSUMPTIVE VALUE $ PER ACRE-FOOT[a]	B INSTREAM VALUE $ PER ACRE-FOOT[b]	A minus B CONSUMPTIVE VALUE MINUS INSTREAM VALUE
GALLATIN RIVER DRAINAGE					
Sourdough Creek	Bozeman	municipal	590.00	77.92	512.08
Wells in Gallatin Valley	Belgrade	municipal	590.00	77.92	512.08
Wells in Gallatin Valley	GA-46	irrigation	131.15	86.53	44.62
Wells in Gallatin Valley	GA-124	irrigation	113.78	86.53	27.25
Wells in Gallatin Valley	GA-44	irrigation	109.79	86.53	23.26
Wells in Gallatin Valley	GA-13	irrigation	109.26	86.53	22.73
Wells in Gallatin Valley	GA-151	irrigation	95.88	86.53	9.35
Wells in Gallatin Valley	GA-79	irrigation	85.00	86.53	-1.53
Wells in Gallatin Valley	GA-24	irrigation	80.95	86.53	-5.58
Wells in Gallatin Valley	GA-14	irrigation	72.50	86.53	-14.03
Wells in Gallatin Valley	GA-41	irrigation	66.30	86.53	-20.23
Wells in Gallatin Valley	GA-81	irrigation	60.75	86.53	-25.78
Wells in Gallatin Valley	GA-35	irrigation	57.75	86.53	-28.78
Wells in Gallatin Valley	GA-40	irrigation	55.77	86.53	-30.76
Wells in Gallatin Valley	GA-92	irrigation	44.71	86.53	-41.82
Wells in Gallatin Valley	GA-143	irrigation	39.91	86.53	-46.62
Wells in Gallatin Valley	GA-130	irrigation	25.99	86.53	-60.54
Wells in Gallatin Valley	GA-110	irrigation	20.12	86.53	-66.41
MADISON RIVER DRAINAGE					
Whiskey Springs	West Yellowstone	municipal	590.00	77.92	512.08
Madison River	GA-201	irrigation	398.49	86.53	311.96
JEFFERSON RIVER DRAINAGE					
Well near Jefferson River	Three Forks	municipal	590.00	77.92	512.08
Jefferson River	JV-25	irrigation	98.39	86.53	11.86
Jefferson River	JV-202	irrigation	85.42	86.53	-1.11
Jefferson River	JV-204	irrigation	73.85	86.53	-12.68
Jefferson River	JV-55	irrigation	62.14	86.53	-24.39
Jefferson River	GA-102	irrigation	61.49	86.53	-25.04
Jefferson River	BR-52	irrigation	50.68	86.53	-35.85
Jefferson River	JV-95	irrigation	49.42	86.53	-37.11
Jefferson River	JV-203	irrigation	43.42	86.53	-43.11
Jefferson River	JV-201	irrigation	33.07	86.53	-53.46
Jefferson River	BR-101	irrigation	28.05	86.53	-58.48
Wells near Boulder River	JV-17	irrigation	114.82	86.53	28.29
Wells near Boulder River	JV-18	irrigation	108.19	86.53	21.66
Wells near Boulder River	JV-80	irrigation	90.89	86.53	4.36
Wells near Boulder River	JV-81	irrigation	88.86	86.53	2.33
Wells near Boulder River	JV-63	irrigation	79.01	86.53	-7.52
BEAVERHEAD RIVER DRAINAGE					
Beaverhead River	Dillon	municipal	590.00	77.92	512.08
MISSOURI RIVER DRAINAGE - THREE FORKS TO HOLTER DAM					
Missouri River	BR-38	irrigation	92.51	77.27	15.24
Missouri River	BR-34	irrigation	68.38	77.27	-8.89
Missouri River	BR-50	irrigation	50.39	77.27	-26.88
Missouri River	BR-111	irrigation	8.83	77.27	-68.44
Canyon Ferry Reservoir	BR-11	irrigation	53.74	77.27	-23.53

Table K-4 (continued)

STREAM	APPLICATION	PURPOSE	A CONSUMPTIVE VALUE $ PER ACRE-FOOT[a]	B INSTREAM VALUE $ PER ACRE-FOOT[b]	A minus B CONSUMPTIVE VALUE MINUS INSTREAM VALUE
Canyon Ferry Reservoir	BR-103	irrigation	51.16	77.27	-26.11
Canyon Ferry Reservoir	BR-108	irrigation	50.21	77.27	-27.06
Canyon Ferry Reservoir	BR-106	irrigation	45.17	77.27	-32.10
Canyon Ferry Reservoir	BR-107	irrigation	39.11	77.27	-38.16
Canyon Ferry Reservoir	BR-14	irrigation	35.87	77.27	-41.40
Canyon Ferry Reservoir	BR-110	irrigation	35.40	77.27	-41.87
Canyon Ferry Reservoir	BR-5	irrigation	35.05	77.27	-42.22
Canyon Ferry Reservoir	BR-12	irrigation	-26.60	77.27	-50.67
Canyon Ferry Reservoir	BR-109	irrigation	20.32	77.27	-56.95
Canyon Ferry Reservoir	BR-104	irrigation	-27.39	77.27	-104.66
Well near Warm Springs Creek	BR-41	irrigation	65.61	77.27	-11.66
Well near Warm Springs Creek	BR-40	irrigation	62.60	77.27	-14.67
Well near Warm Springs Creek	BR-42	irrigation	59.26	77.27	-18.01
Well near Warm Springs Creek	BR-44	irrigation	36.35	77.27	-40.92
Well near Deep Creek	BR-28	irrigation	40.66	77.27	-36.61
Well near Deep Creek	BR-29	irrigation	13.46	77.27	-63.81
Well near Crow Creek	BR-35	irrigation	29.25	77.27	-48.02
Tenmile Creek	LC-11	irrigation	29.23	71.19	45.96
Holter Lake	LCI-10	irrigation	29.80	71.19	-41.39
Wells near Prickly Pear Creek	Helena	municipal	590.00	66.29	523.71
Wells and McClelland Creek	East Helena	municipal	590.00	66.29	523.71
MISSOURI RIVER DRAINAGE - HOLTER DAM TO BELT CREEK					
Missouri River	Great Falls	municipal	590.00	71.19	518.81
Missouri River	CS-101	irrigation	79.74	71.19	8.55
Missouri River	CSI-101	irrigation	75.63	71.19	4.44
Missouri River	CSI-52	irrigation	73.37	71.19	2.18
Missouri River	CSI-103	irrigation	68.14	71.19	-3.05
Missouri River	CS-111	irrigation	66.27	71.19	-4.92
Missouri River	CS-541	irrigation	61.88	71.19	-9.31
Missouri River	CSI-51	irrigation	55.90	71.19	-15.29
Missouri River	CS-102	irrigation	55.75	71.19	-15.44
Missouri River	CSI-22	irrigation	53.24	71.19	-17.95
Missouri River	CSI-11	irrigation	52.37	71.19	-18.82
Missouri River	CS-351	irrigation	51.64	71.19	-19.55
Missouri River	CSI-21	irrigation	46.94	71.19	-24.25
Missouri River	CSI-35	irrigation	44.55	71.19	-26.64
Missouri River	LC-210	irrigation	41.55	71.19	-29.64
Missouri River	CSI-41	irrigation	37.70	71.19	-33.49
Missouri River	CSI-12	irrigation	37.24	71.19	-33.95
Missouri River	CSI-31	irrigation	36.67	71.19	-34.52
Missouri River	CSI-23	irrigation	35.16	71.19	-36.03
Missouri River	CSI-34	irrigation	30.04	71.19	-41.15
Missouri River	CSI-33	irrigation	21.51	71.19	-49.68
Missouri River	CSI-32	irrigation	15.67	71.19	-55.52
DEARBORN RIVER DRAINAGE					
Dearborn River	LCI-20	irrigation	52.06	71.19	-19.13
SMITH RIVER DRAINAGE					
Smith River	CS-61	irrigation	70.53	71.19	-0.66
Smith River	CSI-102	irrigation	56.58	71.19	-14.61
Smith River	CS-271	irrigation	53.06	71.19	-18.13
Smith River	CSI-111	irrigation	44.55	71.19	-26.64
Smith River	CS-252	irrigation	42.35	71.19	-28.84

Table K-4 (continued) STREAM	APPLICATION	PURPOSE	A CONSUMPTIVE VALUE $ PER ACRE-FOOT[a]	B INSTREAM VALUE $ PER ACRE-FOOT[b]	A minus B CONSUMPTIVE VALUE MINUS INSTREAM VALUE
Smith River	CS-331	irrigation	38.35	71.19	-32.84
Smith River	CS-251	irrigation	35.87	71.19	-35.32
Smith River	MEI-12	irrigation	33.48	71.19	-37.71
Smith River	CS-71	irrigation	24.80	71.19	-46.39
Smith River	CSI-120	irrigation	20.78	71.19	-50.41
Smith River	MEI-20	irrigation	19.30	71.19	-51.89
Smith River	MEI-11	irrigation	18.48	71.19	-52.71
Hound Creek	CS-62	irrigation	42.04	71.19	-29.15
Hound Creek	CS-64	irrigation	33.56	71.19	-37.63
Hound Creek	CS-63	irrigation	32.74	71.19	-38.45
SUN RIVER DRAINAGE					
Sun River	Great Falls	municipal	590.00	66.29	523.71
Sun River	TEI-80	irrigation	52.90	71.19	-18.29
Sun River	CSI-83	irrigation	46.67	71.19	-24.52
Sun River	CS-241	irrigation	39.39	71.19	-31.80
Sun River	TEI-100	irrigation	38.42	71.19	-32.77
Sun River	TEI-90	irrigation	33.93	71.19	-37.26
Sun River	CSI-81	irrigation	32.13	71.19	-39.06
Sun River	CSI-82	irrigation	31.37	71.19	-39.82
Sun River	CSI-91	irrigation	29.90	71.19	-41.29
Sun River	CSI-71	irrigation	29.87	71.19	-41.32
Sun River	CS-171	irrigation	27.77	71.19	-43.42
Sun River	CSI-92	irrigation	26.98	71.19	-44.21
Sun River	CS-52	irrigation	24.01	71.19	-47.18
Sun River	CS-471	irrigation	23.22	71.19	-47.97
Sun River	CS-31	irrigation	15.66	71.19	-55.53
Sun River	CS-32	irrigation	9.12	71.19	-62.07
Sun River	CS-51	irrigation	7.55	71.19	-63.64
Sun River	CS-231	irrigation	5.95	71.19	-65.24
Sun River	CSS-200	irrigation	-0.42	71.19	-71.61
Elk Creek	LC-131	irrigation	32.62	71.19	-38.57
Smith Creek	LC-251	irrigation	6.00	71.19	-65.19
Muddy Creek	Power	municipal	590.00	66.29	523.71
Muddy Creek	Fairfield	municipal	590.00	66.29	523.71
Muddy Creek	TE-571	irrigation	40.78	71.19	-30.44
Big Coulee	TE-181	irrigation	46.63	71.19	-24.56
Big Coulee	TE-183	irrigation	34.70	71.19	-36.49
Big Coulee	CS-21	irrigation	1.42	71.19	-69.77
BELT CREEK DRAINAGE					
Belt Creek	CS-43	irrigation	64.21	42.49	21.72
Belt Creek	CS-44	irrigation	43.90	42.49	1.41
Belt Creek	CS-42	irrigation	38.71	42.49	-3.78
Belt Creek	CS-159	irrigation	33.64	42.49	-8.85
Belt Creek	CHS-1	irrigation	0.60	42.49	-41.89
Big Otter Creek	JB-281	irrigation	45.35	42.49	2.86
Little Otter Creek	JB-61	irrigation	47.00	42.49	4.51
MARIAS RIVER DRAINAGE					
Cut Bank Creek	Cut Bank	municipal	590.00	32.71	557.29
Cut Bank Creek	GL-221	irrigation	53.95	34.10	19.85
Cut Bank Creek	GL-11	irrigation	46.39	34.10	12.29
Wells near Marias River	Shelby	municipal	590.00	32.71	557.29

Table K-4 (continued)

STREAM	APPLICATION	PURPOSE	A CONSUMPTIVE VALUE $ PER ACRE-FOOT[a]	B INSTREAM VALUE $ PER ACRE-FOOT[b]	A minus B CONSUMPTIVE VALUE MINUS INSTREAM VALU
Marias River	CHI-53	irrigation	53.98	34.10	19.88
Marias River	LI-161	irrigation	52.38	34.10	18.28
Marias River	LI-162	irrigation	46.40	34.10	12.30
Marias River	CHI-51	irrigation	39.50	34.10	5.40
Marias River	LI-263	irrigation	29.80	34.10	-4.30
Marias River	TO-221	irrigation	22.29	34.10	-11.81
Marias River	LI-262	irrigation	20.48	34.10	-13.62
Marias River	BS-32	irrigation	15.78	34.10	-18.32
Marias River	LI-261	irrigation	15.53	34.10	-18.57
Marias River	CHI-52	irrigation	15.21	34.10	-18.89
Marias River	HI-269	irrigation	9.66	34.10	-24.44
Marias River	LI-91	irrigation	9.33	34.10	-24.17
Marias River	BS-31	irrigation	2.92	34.10	-31.18
Marias River	BSS-2	irrigation	0.46	34.10	-33.64
Whitetail Creek	GL-201	irrigation	26.00	34.10	-8.10
Dry Fork Marias River	PO-211	irrigation	27.00	34.10	-7.10
Lake Francis	Conrad	municipal	590.00	34.10	555.90
Timber Coulee	TO-421	irrigation	8.00	34.10	26.10
Laughlin Coulee	PO-91	irrigation	4.00	34.10	-30.10
Tiber Reservoir	Chester	municipal	590.00	32.71	557.29
Tiber Reservoir	TO-341	irrigation	49.02	34.10	14.92
Tiber Reservoir	TO-342	irrigation	17.90	34.10	-16.20
Tiber Reservoir	TO-211	irrigation	-2.70	34.10	-36.80
Birch Creek	PO-171	irrigation	69.26	34.10	35.16
Birch Creek	PO-251	irrigation	31.00	34.10	-3.10
Two Medicine River	POI-10	irrigation	57.30	34.10	23.20
Two Medicine River	PO-421	irrigation	33.58	34.10	-0.52
Unnamed tributary Bullhead Creek	PO-271	irrigation	36.23	34.10	2.13
Unnamed tributary Bullhead Creek	PO-411	irrigation	28.85	34.10	-5.25
TETON RIVER DRAINAGE					
Wells near Spring Creek	Choteau	municipal	590.00	32.71	557.29
Gamble Coulee	TE-591	irrigation	115.11	34.10	81.01
Teton River	TE-321	irrigation	70.55	34.10	36.45
Muddy Creek	TE-101	irrigation	56.64	34.10	22.54
Teton River	TEI-40	irrigation	53.83	34.10	19.73
Gamble Coulee	TE-581	fish, wildlife	52.06	34.10	17.96
Teton River	CHI-80	irrigation	46.37	34.10	12.27
Teton River	TEI-60	irrigation	43.19	34.10	9.09
Teton River	TEI-50	irrigation	42.29	34.10	8.19
Teton River	CHI-72	irrigation	41.74	34.10	7.64
Teton River	CHI-61	irrigation	41.74	34.10	7.64
Unnamed TributaryTeton River	TE-401	irrigation	21.00	34.10	-13.10
Spring Coulee	TE-361	irrigation	41.00	34.10	6.90
Teton River	TEI-10	irrigation	40.41	34.10	6.31
Teton River	TEI-30	irrigation	38.79	34.10	4.69
Teton River	CHI-74	irrigation	38.39	34.10	4.29
Teton River	TE-411	irrigation	29.04	34.10	-5.06
Teton River	TEI-20	irrigation	24.66	34.10	-9.44
Teton River	TEI-70	irrigation	22.54	34.10	-11.56
Teton River	TE-282	irrigation	22.37	34.10	-11.73
Teton River	TE-281	irrigation	16.41	34.10	-17.69
Teton River	CH-381	irrigation	6.94	34.10	-27.16
Muddy Creek	TE-81	irrigation	4.74	34.10	-29.36
Alkali Coulee	CH-641	wildlife	-10.09	34.10	-44.19

Table K-4 (continued)

STREAM	APPLICATION	PURPOSE	A CONSUMPTIVE VALUE $ PER ACRE-FOOT[a]	B INSTREAM VALUE $ PER ACRE-FOOT[b]	A minus B CONSUMPTIVE VALUE MINUS INSTREAM VALUE
MISSOURI RIVER DRAINAGE - BELT CREEK TO FORT PECK RESERVOIR					
Missouri River	Fort Benton	municipal	590.00	32.71	557.29
Missouri River	CH-21	irrigation	71.26	34.10	37.16
Missouri River	FEI-10	irrigation	57.51	34.10	23.41
Missouri River	CHI-30	irrigation	50.58	34.10	16.48
Missouri River	CHI-40	irrigation	48.69	34.10	14.59
Missouri River	CHI-21	irrigation	45.98	34.10	11.88
Missouri River	CHI-22	irrigation	40.50	34.10	6.40
Missouri River	CHI-10	irrigation	37.14	34.10	3.04
Missouri River	CHS-5	irrigation	29.13	34.10	-4.97
Missouri River	CHS-3	irrigation	26.54	34.10	-7.56
Missouri River	BUREC	irrigation	21.75	34.10	-12.35
Missouri River	CH-211	irrigation	15.84	34.10	-18.26
Missouri River	FEI-30	irrigation	15.17	34.10	-18.93
Missouri River	CH-511	irrigation	12.06	34.10	-22.04
Missouri River	FEI-20	irrigation	10.39	34.10	-23.71
Missouri River	CH-371	irrigation	2.22	34.10	-31.88
Missouri River	CHS-6	irrigation	-4.62	34.10	-38.72
Shonkin Creek	CH-201	irrigation	54.31	34.10	20.21
Highwood Creek	CH-541	irrigation	9.87	34.10	-24.23
Big Sag Coulee	CH-551	irrigation	67.84	34.10	33.74
Cut Bank Coulee	CH-181	fire protection, recreation	NA	NA	NA
JUDITH RIVER DRAINAGE					
Well near Judith River	Winifred	municipal	590.00	32.71	557.29
Judith River	JBI-2	irrigation	23.77	34.10	-10.33
Judith River	FEI-50	irrigation	7.98	34.10	-26.12
Judith River	FE-41	irrigation	1.51	34.10	-32.59
Wolverine Creek	FE-141	irrigation	64.49	34.10	30.39
Little Casino Creek	FE-431	irrigation	42.63	34.10	8.53
Olsen Creek	FE-671	irrigation	49.12	34.10	15.02
Unnamed Tributary Olsen Creek	FE-672	irrigation	61.81	34.10	27.71
Ross Fork Creek	FE-673	irrigation	51.60	34.10	17.50
Unnamed Tributary Campbell Creek	FE-42	irrigation	-7.00	34.10	-1.10
Wolf Creek	FE-81	irrigation	1.00	34.10	-33.10
McCarthy Creek	JB-111	irrigation	32.00	34.10	-2.10
Running Wolf Creek	JBS-3	irrigation	75.02	34.10	40.92
Running Wolf Creek	JB-261	irrigation	29.94	34.10	-4.16
Louse Creek	JB-21	irrigation	25.78	34.10	-8.32
Wells near Louse Creek	JB-231	irrigation	20.01	34.10	-14.09
Wells near Louse Creek	JB-232	irrigation	20.01	34.10	-14.09
Little Trout Creek	JB-309	irrigation	3.00	34.10	-31.10
Big Spring Creek	FE-111	irrigation	0.63	34.10	-33.47
Big Spring Creek	Lewistown	municipal	590.00	32.71	557.29
East Fork Big Spring Creek	FE-401	irrigation	38.86	34.10	4.76
Warm Springs Creek	FE-161	irrigation	32.64	34.10	-1.46
Warm Springs Creek	FEI-40	irrigation	28.22	34.10	-5.88
Warm Springs Creek	FE-561	irrigation	0.00	34.10	-34.10
MUSSELSHELL RIVER DRAINAGE					
Musselshell River	LM-20	irrigation	156.19	34.10	122.09
FORT PECK DRAINAGE					
Fort Peck Reservoir	VAS-1	irrigation	16.33	34.10	-17.77

[a] Positive numbers indicate the benefits are greater than costs for the proposed use.

[b] Negative numbers indicate costs of the proposed use would be greater than the benefits of leaving water instream.

Table K-5. Value of instream flows on streams with competing consumptive use requests

Drainage	Stream	Applicant	Instream Value $ per acre-foot	Fisheries Value Class[ab]
Gallatin River	Ben Hart Spring Creek	DFWP	77.92	6
	East Gallatin River #1	DFWP	77.92	2
	East Gallatin River #2	DFWP	77.92	2
	East Gallatin River #3	DFWP	77.92	3
	Gallatin River #1	DFWP	77.92	2
	Gallatin River #2	DFWP	77.92	1,2,3
	Gallatin River #3	DFWP	77.92	2
	Hyalite Creek #2	DFWP	77.92	4
	Sourdoug Creek	DFWP	77.92	3
	Thompson Spring Creek	DFWP	77.92	3,4
Madison River	Madison River #2	DFWP	77.92	1
	Madison River #3	DFWP	77.92	1
	Madison River #4	DFWP	77.92	1
	South Fork Madison River	DFWP	77.92	3
Jefferson River	Boulder River #2	DFWP	77.92	4
	Boulder River #3	DFWP	77.92	3
	Jefferson River	DFWP	77.92	2
Beaverhead River	Beaverhead River #2	DFWP	77.92	3
Missouri River—Three Forks to Holter Dam	Deep Creek	DFWP	72.37	3
	Missouri River #1	DFWP	72.37	1,3
	Missouri River at Toston	DHES	72.37	NA
	Prickly Pear Creek #1	DFWP	66.29	2,3,4
	Tenmile Creek	DFWP	66.29	4
	Warm Springs Creek	DFWP	72.37	6
	Missouri River #2	DFWP	66.29	1
Missouri River—Holter Dam to Belt Creek	Missouri River #3	DFWP	66.29	1,3
	Missouri River at Ulm	DHES	66.29	NA
Dearborn River	Dearborn River	DFWP	66.29	3
Smith River	Smith River #1	DFWP	66.29	3,2
	Smith River #2	DFWP	66.29	2
	Smith River #3	DFWP	66.29	4,3
	Hound Creek	DFWP	66.29	3
Sun River	Sun River #1	DFWP	66.29	3
	Sun River #2	DFWP	66.29	3
	Elk Creek	DFWP	66.29	3
Belt Creek	Belt Creek #2	DFWP	37.59	3
	Big Otter Creek	DFWP	37.59	6
Marias River	Cut Bank Creek	DFWP	32.71	3
	Marias River #1	DFWP	32.71	3
	Marias River #2	DFWP	32.71	3
	Marias River #3	DFWP	32.71	2
Teton River	Teton River	DFWP	32.71	3

Table K-5 (continued)

Drainage	Stream	Applicant	Instream Value $ per acre-foot	Fisheries Value Class[ab]
Missouri River Drainage—Belt Creek to Fort Peck Reservoir	Highwood Creek	DFWP	32.71	3,4
	Missouri River #4	DFWP	32.71	1
	Missouri River #5	DFWP	32.71	1
	Missouri River #6	DFWP	32.71	1
	Missouri River at Virgelle	DHES	32.71	NA
	Missouri River at Landusky	DHES	32.71	NA
	Shonkin Creek	DFWP	32.71	3
Judith River	Big Spring Creek #1	DFWP	32.71	1
	Big Spring Creek #2	DFWP	32.71	1
	Judith River #1	DFWP	32.71	3,4
	Judith River #2	DFWP	32.71	3
Musselshell River	Musselshell River #2	DFWP	32.71	2,3
	Musselshell River #3	DFWP	32.71	3

[a] 1 = outstanding fisheries resource
2 = high value fisheries resource
3 = substantial fisheries resource
4 = moderate fisheries resoruce
5 = limited fisheries resource
6 = unrated reach

[b]Some stream reaches where reservations are requested may encompass more than one fisheries value class.

Table K-6. Municipal water costs

Town	Thousands of Gallons/Year	Annual Cost[a]	Dollars Per Thousand of Gallons[b]
Belgrade	210,174	$37,000	$0.18
Bozeman	1,313,180	$939,000	$0.72
Chester	141,745	$0	$0.00
Choteau	157,060	$187,000	$1.19
Conrad	58,082	$221,000	$3.81
Cut Bank	147,362	$131,000	$0.89
Dillon	65,822	$14,000	$0.21
East Helena	84,070	$109,000	$1.30
Fairfield	32,585	$72,000	$2.20
Fort Benton	29,001	$41,000	$1.43
Great Falls	3,467,500	$2,261,000	$0.65
Helena	2,340,200	$1,170,000	$0.50
Lewistown	230,051	$131,000	$0.57
Power	9,053	$22,000	$2.42
Shelby	98,407	$228,000	$2.32
Three Forks	26,394	$12,000	$0.45
West Yellowstone	194,910	$167,000	$0.86
Winifred	15,841	$29,000	$1.83
TOTAL	8,621,437	$5,771,000	Average $0.67

[a] Values are rounded to the nearest thousand dollars.
[b] Values are rounded to the nearest cent.

Table K-7. Municipal water system characteristics

Municipal Requests	Water Distribution Systems with Substantial Leakage	Percent of Service Metered	Unmetered Service
Belgrade	Yes	18%	
Bozeman	Yes	98%	
Chester		19%	
Choteau	Yes	—	Yes
Conrad		31%	
Cut Bank		100%	
Dillon		99%	
East Helena	Yes	—	Yes
Fairfield		—	Yes
Fort Benton	Yes	21%	
Great Falls		96%	
Helena		99%	
Lewistown	Yes	16%	
Power		—	Yes
Shelby		100%	
Three Forks		100%	
West Yellowstone		100%	
Winifred		60%	

Source: Information based on municipal water reservation applications submitted to DNRC

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APPROXIMATE WATER EQUIVALENTS

1 cubic foot = 7.48 gallons

1 acre-foot (af) = 43,560 cubic feet, or 325,851 gallons
An acre-foot covers one acre of land one foot deep.

1 cubic foot per second (cfs) = 448.8 gallons per minute

1 cfs = 40 Montana statutory miner's inches

1 cfs = 646,316 gallons per day
for 24 hours = 1.98 acre-feet
for 30 days = 59.5 acre-feet
for 1 year = 725 acre-feet

1 million gallons = 3.07 acre-feet

1 million gallons per day (mgd) = 1,122 acre-feet per year

1,000 gallons per minute (gpm) = 2.23 cfs

1,000 gpm = 4.42 acre-feet per day

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